TITLE OF THE INVENTION

Shelter System and Associated Devices

The present invention relates to shelter systems for humans, and more specifically to shelters and related devices for protection from chemical, biological and radiological agents.

Political and criminal events in the early 21st Century have raised the threat of a terrorist attack by "weapons of mass destruction", such as chemical, biological or radiological agents, to an unprecedented level. As such, systems for protection of persons from such attacks have become highly desirable.

SUMMARY OF THE INVENTION

In one aspect, the present invention is a shelter system for use within an environment having air. The shelter system comprises an enclosure disposeable within the environment and formed of an air impermeable material. The enclosure is configured to define an interior chamber, to contain a quantity of air within the chamber, and to substantially prevent entry of the environment air into the chamber. An oxygen generator is disposeable within the enclosure, the oxygen generator including a chemical oxygen generation material for generating oxygen and being configured to discharge oxygen into the enclosure air. Further, a carbon dioxide removal device is disposeable within the enclosure and includes an interior chamber and a reactive material disposed within the removal device chamber and configured to remove carbon dioxide from the enclosure air.

In another aspect, the present invention is a shelter for isolating at least one person from an environment having air. The shelter comprises an enclosure formed of an air impermeable material and disposeable within the environment, the enclosure being configured to define an interior chamber. The enclosure is expansible from a storage configuration, in which the chamber has a minimum volume, to a usage configuration in which the chamber has a maximum volume, the maximum volume being of sufficient magnitude to entirely contain at least one person. The enclosure is further configured to contain a quantity of air within the chamber when disposed in the usage configuration and to at least one of substantially prevent entry of the environment air into the enclosure chamber and substantially prevent egress of enclosure air into the environment.

In a further aspect, the present invention is a method of constructing a shelter within a building having at least one room, the room having an interior space. The method

comprises the steps of: providing a plurality of sheets of a generally flexible material, determining a number of sheets required to enclose a desired portion of the room interior space, and attaching each one of the required number of sheets to at least one of the other sheets so as to form a generally air impermeable enclosure, the enclosure being disposeable within the desired room portion so as provide an interior chamber isolateable from a remainder of the room interior space.

In yet another aspect, the present invention is a shelter for isolating at least one person from an environment having air. The shelter comprises an enclosure disposeable within the environment, formed of an air impermeable material and having an exterior surface and an interior surface, the interior surface bounding an interior chamber. The enclosure is configured to contain a quantity of air within the chamber and to maintain the chamber air substantially separated from the environment air. Further, a connector unit is attached to the enclosure and is configured to electrically connect at least one electrical device located within the enclosure chamber with an electrical power supply located within the environment. The connector unit is further configured to substantially prevent air flow through the connector unit.

In an even further aspect, the present invention is an oxygen generator for providing oxygen to a chamber of an enclosure, the chamber having a volume of a sufficient magnitude so as to entirely contain at least one person. The oxygen generator comprises a housing disposeable within the enclosure chamber and having an interior chamber and an opening. The opening extends into the interior chamber and is fluidly connectable with the enclosure chamber. Further, a quantity of an oxygen-producing material is removably disposeable within the housing chamber and is configured to generate oxygen by spontaneous chemical reaction. The housing is configured such that the oxygen generated by the material flows from the housing chamber, through the housing opening and into the enclosure chamber.

In yet an additional aspect, the present invention is an air treatment device for removing carbon dioxide from air contained within a chamber of an enclosure, the enclosure chamber having a volume of sufficient magnitude to entirely contain at least one person. The air treatment device comprises a housing disposeable within the enclosure chamber and having an interior chamber, the chamber being configured to receive a quantity of a reactive material for removing carbon dioxide from air. An inlet port fluidly connects the housing chamber with the enclosure chamber and an outlet port fluidly connects the housing chamber with the enclosure chamber. Further, a fan is connected

with the housing and is configured to initiate flow of a portion of the air within the enclosure chamber into the inlet port, through the housing chamber, out of the outlet port and back to the enclosure chamber.

In an even further additional aspect, the present invention is an air treatment device for removing carbon dioxide and water from air contained within a chamber of an enclosure, the enclosure chamber having a volume of sufficient magnitude to entirely contain at least one person. The air treatment device comprises first and second removal units disposeable within the enclosure chamber. The first removal unit has an interior chamber, the chamber being configured to receive a quantity of a first reactive material for removing one of carbon dioxide and water from air, an inlet port fluidly connecting the interior chamber with the enclosure chamber, and an outlet port fluidly connected with the interior chamber. The second removal unit has an interior chamber, the second unit chamber being configured to receive a quantity of a second reactive material for removing the other one of carbon dioxide and water from air, an inlet port fluidly connected with the first unit outlet port and an outlet port fluidly connecting the second unit chamber with the enclosure chamber.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

The foregoing summary, as well as the detailed description of the preferred embodiments of the present invention, will be better understood when read in conjunction with the appended drawings. For the purpose of illustrating the invention, there is shown in the drawings, which are diagrammatic, embodiments that are presently preferred. It should be understood, however, that the present invention is not limited to the precise arrangements and instrumentalities shown. In the drawings:

Fig. 1 is an elevational plan view of a safe room system in accordance with the present invention, shown installed in a building;

Fig. 2 is a top plan view of the safe room system, showing an alternative enclosure construction;

Fig. 3 is an elevational plan view of the safe room system, showing another alternative construction of the enclosure;

Fig. 4 is an elevational plan view of the safe room system, showing yet another alternative construction of the enclosure;

Fig. 5 is another view of the system of Fig. 4, showing the enclosure in a storage configuration within a single room of the building;

Fig. 6 is yet another view of the system of Fig. 4, showing the enclosure in a collapsed position;

Fig. 7 is a top plan view of the safe room system, showing an even further alternative construction of the enclosure and a decontamination enclosure;

Fig. 8 is a partly broken-away, perspective view of another alternative construction of the enclosure, shown with a plurality of support frames;

Fig. 9 is a perspective view of the safe room system shown in a first vehicle application;

Fig. 10 is another view of the enclosure of Fig. 9;

Fig. 11 is top plan view of the safe room system shown in a second vehicle application;

Fig. 12 is a perspective view of a two-section enclosure;

Fig. 13 is a broken-away, perspective view of a single enclosure section, shown installed within a room;

Fig. 14 is an enlarged, broken-away, top plan view of the enclosure shown engaged with a bathroom sink, a toilet, a shower head and a tub;

Fig. 15 is an enlarged broken-away, perspective view of the enclosure shown engaged with a toilet;

Fig. 16 is an enlarged broken-away, perspective view of the enclosure shown engaged with a shower;

Fig. 17 is broken-away, perspective view of a connective insert shown connecting two enclosure sections through a doorway;

Fig. 18 is sectional view through a connective insert disposed in a doorway;

Fig. 19 is a greatly enlarged, broken-away sectional view through the enclosure, showing the layers of a first preferred material sheet and depicting a joint of two first sheets;

Fig. 20 is a greatly enlarged, broken-away sectional view through the enclosure, showing the layers of a second material sheet and depicting a joint between the first and second material sheets;

Fig. 21 is an elevational view of a presently preferred oxygen generator device;

Fig. 22 is an elevational view of an alternative oxygen generator;

Fig. 23 is an elevational view of the oxygen generator and an air manifold, shown installed in different rooms of a building;

Fig. 24 is an elevational view of an emitter housing of the oxygen generator;

Fig. 25 is another elevational view of an emitter housing of the oxygen generator;

Fig. 26 is an elevational view of one preferred construction of an air treatment device;

Fig. 27 is an elevational view of another preferred construction of an air treatment device;

Fig. 28 is an elevational view of an alternative construction of the air treatment device of Fig. 27;

Fig. 29 is an elevational view of an alternative construction of the air treatment device;

Fig. 30 is an elevational view of another alternative construction of the air treatment device;

Fig. 31 is an elevational view of yet another alternative construction of the air treatment device;

Fig. 32 is a top view of the device shown in Fig. 31;

Fig. 33 is front elevational view of a connector unit of the safe room system;

Fig. 34 is side cross-sectional view of the connector unit;

Fig. 35 is a more diagrammatic top plan view of the connector unit, shown connected with a plurality of electrical devices; and

Fig. 36 is another, more diagrammatic top plan view of the connector unit, shown connected with a plurality of fluid devices.

DETAILED DESCRIPTION OF THE INVENTION

Certain terminology is used in the following description for convenience only and is not limiting. The words “right”, left”, “lower”, “upper”, “upward”, “down” and “downward” designate directions in the drawings to which reference is made. The words "inner", "inwardly" and "outer", "outwardly" refer to directions toward and away from, respectively, a designated centerline or a geometric center of an element being described, the particular meaning being readily apparent from the context of the description. Further, as used herein, the word "connected" is intended to include direct connections between two members without any other members interposed therebetween and indirect connections between members in which one or more other members are interposed therebetween. The terminology includes the words specifically mentioned above, derivatives thereof, and words of similar import.

Referring now to the drawings in detail, wherein like numbers are used to indicate like elements throughout, there is shown in Figs. 1-36 a presently preferred embodiment of a shelter system 10 for use within an environment E having an atmosphere or air A_E in order to provide protection from any chemical, biological, radiological or other harmful substance, referred to hereinafter collectively as "dangerous agents". The shelter system 10 basically comprises an enclosure 12 disposeable within the environment E and formed of a substantially air impermeable material 24, an oxygen generator 14, and an air treatment device 16, the generator 14 and treatment device 16 each being disposeable within the enclosure 12. The enclosure 12 is configured to define an interior chamber C_E, to contain a quantity of air A_C within the chamber C_E and to substantially prevent entry of the environment air A_E into the chamber C_E. Preferably, the enclosure 12 is further configured to substantially prevent egress of the enclosure air A_C to the environment E, such that the enclosure air A_C is substantially separated or isolated from the environment air/atmosphere A_E. Further, the oxygen generator 14 includes a chemical oxygen generation device 15 for generating oxygen and is configured to discharge oxygen into the enclosure air A_C. Additionally, the air treatment device 16 includes at least an interior chamber 17 and a reactive material 18 disposed within the chamber 17, the material 18 being configured to remove carbon dioxide from the enclosure air A_C, and preferably further includes another reactive material 19 for removing water from the air A_C, as discussed below.

Preferably, the enclosure 12 is generally flexible and is configured to expand from a storage configuration (Figs. 5, 6, and 9) to a deployed configuration (Figs. 1-4, 7, 8, 10-13) and to alternatively contract from the usage configuration to the storage configuration. More specifically, the enclosure 12 is expansible from the collapsed, storage configuration, in which the enclosure chamber C_E has a minimum volume, to the deployed or "usage" configuration (i.e., suitable for use as a habitation) in which the chamber C_E has a maximum volume, the maximum volume being of sufficient magnitude to entirely contain at least one person. The enclosure 12 includes at least one and preferably a plurality of relatively thin sheets 25 of a substantially air impermeable material 24 (described below) formed into a sealable or closeable bag 13, as discussed in further detail below. As the entire enclosure 12 is substantially air impermeable, the enclosure air A_C may have pressure equal to or even lesser than the environment air A_E. However, the enclosure 12 is configured so as to be capable of containing the enclosure air A_C at a "positive" pressure, or pressure greater than the surrounding atmosphere, so as prevent the

environment air A_E from entering the enclosure 12 in the event that a rupture or leak forms in the enclosure material 24.

Referring to Figs. 1-8, in one application, the shelter system 10 is used within the environment E that includes a building B, in which the enclosure 12 is disposeable within and occupies at least a portion of the building interior space S_R. The building B may have at least first and second rooms R_1, R_2, and may have any number of additional rooms R_3, R_4, etc., each of the rooms R_1, R_2, R_3, etc., having or defining an interior space S_{R1}, S_{R2}, S_{R3}, etc., within which the building air A_E is contained. As such, the enclosure 12 preferably includes a plurality of enclosure sections 20, more specifically, at least a first enclosure section 21A and a second enclosure section 21B, with the enclosure chamber C_E extending through/throughout the two or more enclosure sections 21A, 21B, etc. The first enclosure section 21A is disposeable within the first room R_1 so as to occupy at least a portion of the first room interior space S_{R1} and bounds a first interior chamber section C_{S1}. The second enclosure section 21B is connected with the first section 21A, is disposeable within the second room R_2 so as to occupy at least a portion of the second room interior space S_{R1} and bounds a second interior chamber section C_{S2}. Most preferably, the first and second sections 21A, 21B (and any other enclosure sections), are removably connected together such that each section 21A, 21B may be first placed within each associated room R_1, R_2, and then connected together to form the overall enclosure 12, and later disconnected or detached from each other for subsequent storage, as best shown in Fig. 6. Further, the two or more interior chamber sections C_{S1}, C_{S2}, etc., provide a habitation for at least one person, and preferably multiple persons as discussed below. In addition, the enclosure 12 may include a third enclosure section 21C, a fourth enclosure section 21D, a fifth enclosure section 21E, etc., depending on the number of rooms R in the building B that are desired to be incorporated into the safe room system 10, as discussed below.

Referring to Figs. 7 and 14-16, in such a "building" application, the enclosure 12 is also preferably used with a building B that includes at least one appliance fixture F_n, such as a bathroom sink F_1, a toilet F_2, a bathroom showerhead F_3, a bathtub F_4 and/or a kitchen sink (not shown). As such, the enclosure 12 preferably has at least one and preferably a plurality of fixture-access openings 22 each configured to sealingly engage about at least a portion of one of the appliance fixtures F_n. Preferably, each access opening 22 is disposeable about a portion of the associated fixture F_n and then sealingly attached to the fixture F by means of an air-impermeable connector 33 (e.g., aluminum duct tape, etc.). Most preferably, the connector 33 includes a first portion 33a disposed about the enclosure

opening 32 and a second portion 33b attached to the fixture F_n or a surface adjacent to the fixture F_n. As such, the appliance fixture F_n is generally usable by a person located within the enclosure 12 while the enclosure 12 maintains the enclosure atmosphere A_E substantially isolated from the building atmosphere A_B, and thereby also from all external air.

Referring to Figs. 9-11, in another application, the shelter system 10 is used within an environment E that includes a vehicle V having at least one interior chamber C_V. In such a case, the enclosure 12 is disposed or disposeable at least partially within the vehicle chamber V_C, but is otherwise substantially similar or identical in construction as the enclosure 12 used in the building B. The vehicle V may be any mobile transport that may be exposed to a dangerous agent, such as for example, an automobile, a sport utility vehicle, a mini van, a van, a bus, a truck, a tractor trailer, an emergency vehicle, an ambulance, an armored transport, a tank, an airplane, a helicopter, a ship, a boat, a submarine or any other appropriate vehicle. In certain vehicle applications, such as when the vehicle V may be used to transport persons exposed to a dangerous agent, it is very important that the enclosure 12 is configured to both substantially prevent entry of the environment air A_E into the enclosure chamber C_E and to substantially prevent egress of the enclosure air A_C to the environment E. As such, none of the agent that may be brought into the enclosure 12 within the vehicle V by such exposed persons is able to escape to the environment E, enabling the vehicle V to be utilized to transport exposed persons from an exposed environment E to a safe environment E for subsequent decontamination and/or treatment.

Preferably, when the vehicle V is a "land based" vehicle (i.e., car, truck, van, etc.), the enclosure 12 includes a first section 21A disposeable within the vehicle chamber C_V and a second section 21B disposeable externally of the vehicle V. As the enclosure 12 is preferably expansible from a storage configuration (Fig. 9) to a usage configuration (Fig. 10) as discussed above, the enclosure 12 is entirely disposeable or "containable" within the vehicle chamber V_C when the enclosure 12 is disposed in the storage configuration. As such, the enclosure 12 may provide a much larger interior chamber C_E than is available from occupying only a portion of the vehicle V itself, which is very beneficial when using the shelter 10 for applications such as establishing a command post, a hospital, a treatment facility, etc.

Furthermore, as discussed in detail below, the enclosure 12 is preferably custom built or fit for one specific building B, vehicle V, or other environmental space within

which it is intended to be used. Such an enclosure 12 is preferably constructed generally by the following method. A plurality of sheets 24 of a generally flexible, air impermeable material are provided and the number of sheets 24 required to enclose a desired portion of the room interior space S_R or vehicle chamber space S_V is determined. Each one of the required number of material sheets 24 is attached to at least one of the other sheets 24 so as to form the generally air impermeable enclosure 12, preferably the bag 13, such that the formed enclosure 12 is disposeable within the desired room or chamber portion to provide an interior chamber C_E isolateable from a remainder of the room interior space S_R or vehicle chamber space S_V, as discussed above and in further detail below.

Although preferably used within a building B or vehicle V, the shelter system 10 may be used within any other appropriate enclosed environment E, such as within a mine or cave (neither shown). Further, the shelter system 10 may also be used in a completely "open" environment, such as for example, in a yard, parking lot or a field, in woods, on a desert plain, on a mountain side, etc. The scope of the present invention includes these and all other appropriate applications of the shelter system 10.

Referring particularly to Fig. 21, the generation device 15 of the oxygen generator 14 preferably includes a housing 26 disposeable within the enclosure chamber C_E and a quantity Q of an oxygen-producing material 28 disposeable within housing 26 and configured to generate oxygen by spontaneous chemical reaction. The housing 26 has an interior chamber 30 and an opening 32 extending into the interior chamber 30, the opening 32 being fluidly connectable with the enclosure chamber C_E. The quantity of an oxygen-producing material 28 is removably disposeable within the housing chamber 30 and is preferably a chemical compound that generates oxygen through a chemical reaction of thermal decomposition, most preferably sodium percarbonate, but may be any other appropriate chemical compound or device as discussed below. Further, the housing 26 is configured such that the oxygen generated by the material 28 flows from the housing chamber 30, through the housing opening 32 and into the enclosure chamber C_E. The quantity Q of oxygen-producing material 28 is adequate to generate a quantity of oxygen sufficient to maintain the percentage of oxygen within the enclosure air A_E above a minimum value, preferably about twenty percent (20%) and sufficient to support at least one person located within the enclosure chamber C_E for a predetermined period of time (e.g., 72 hours), as discussed below.

Preferably, the oxygen-producing material 28 is provided as a granular mass of material that is placeable or "pourable" into the housing chamber 30, preferably through

the opening 32. Most preferably, the oxygen generator 14 further comprises a supply 31 of oxygen-producing material 28 located externally of the housing chamber 30, such that the quantity Q of the material 28 within the housing chamber 30 is replenishable from the material supply 31. Further, the generator 14 also preferably comprises a quantity of a chemical reaction initiating material 34 disposeable within the housing chamber 14, which is most preferably a volume of water 35. The oxygen-producing material 28 is contactable with the reaction initiating material 34 such that the oxygen-producing material 28 chemically reacts to produce oxygen, the oxygen-producing material 28 being a non-reactive or inert state until chemical reaction is initiated. Preferably, the water 35 is first placed or poured into the chamber 26, and then the oxygen-producing material 28 is disposed within (i.e., poured into) the water 35 so that chemical reaction is generally immediately initiated, as discussed below. Furthermore, the oxygen-generator device 14 also preferably comprises a catalyst material 36 disposed within the housing chamber 30 and contactable with the oxygen-producing material 28. The catalyst material 36 is configured to increase the rate of the chemical reaction of the oxygen-producing material 28, and thus the rate of oxygen production. The catalyst material 36 is preferably manganese acetate tetrahydrate and is preferably combined or mixed with the water 35 prior to pouring the preferred sodium percarbonate 28 into the water 35.

Referring now to Fig. 26, in one preferred construction 39, the air treatment device 16 basically includes at least one housing 40 defining the interior chamber 17 and having an inlet 42 fluidly connecting the enclosure chamber C_E with the device chamber 17, and an outlet 43 fluidly connecting the device chamber 17 with the enclosure chamber C_E. A fan 46 is configured to initiate flow F_{AC} of a portion of the enclosure air A_E into the inlet 42, through the removal chamber 17, out of the outlet 42 and back to enclosure chamber C_E. As such, when the reactive material 18 is disposed within the housing chamber 17 and the air portion F_{AC} flows through the chamber 17, at least a portion of any carbon dioxide within the air flow portion F_{AC} is removed by contact with the reactive material 18. Thereby, the total amount of carbon dioxide within the enclosure air A_C is reduced so as to maintain a habitable condition for the one or more persons located within the enclosure chamber C_E.

Preferably, the reactive material 18 is a carbon-dioxide absorbent, and most preferably, is a granular mass of calcium hydroxide, but may be any other appropriate carbon dioxide removal substance, as discussed below. Further, the treatment device 16 also preferably includes a sensor 47 configured to sense carbon-dioxide within the

enclosure air A_C and a controller 48 coupled with the sensor 47 and operatively connected with the fan 46. The controller 48 is configured to operate the fan 46 so as to maintain a level of carbon dioxide within the enclosure air A_C below a predetermined value, as discussed in further detail below, although the fan 46 may alternatively be continuously operated or manually controlled.

Referring to Fig. 27, in another, presently most preferred construction 59, the air treatment device 16 is configured to remove both carbon dioxide and water from the enclosure air A_C. The second construction 59 of the treatment device 16 includes a first removal unit 50 containing a first reactive material 52 for removing carbon dioxide or water from air, a second removal unit 54 containing a second reactive material 56 for removing the other one of the carbon dioxide and water from air, and a fan 58 configured to initiate flow through the two removal units 50, 52. The first removal unit 50 has an interior chamber 60 configured to receive a quantity of a first reactive material 52, an inlet port 62 fluidly connecting the interior chamber 60 with the enclosure chamber C_E, and an outlet port 64 fluidly connected with the interior chamber 60. The second removal unit 54 has an interior chamber 61 configured to receive a quantity of the second reactive material 56, an inlet port 63 fluidly connected with the first unit outlet port 64, and an outlet port 65 fluidly connecting the second unit chamber 61 with the enclosure chamber C_E.

The fan 58 is connected with at least one of the two removal units 50, 52 and is configured to initiate flow of a portion of the air A_C within the enclosure chamber C_E into the first unit inlet port 62, through the first and second unit chambers 60, 61, out of the second unit outlet 65 and back to the enclosure chamber C_E. As such, when the first reactive material 52 is disposed within the first unit chamber 60, the second reactive material 56 is disposed within the second unit chamber 61 and a portion F_{AC} of the enclosure air A_C flows through the two unit chambers 61, 62, at least a portion of any carbon dioxide within the air flow portion F_{AC} is removed by one of the two reactive materials 52, 56 and at least a portion of any water within the air flow portion F_{AC} is removed by the other one of the two reactive materials 56, 52.

Thereby, the total amount of carbon dioxide and water within the enclosure air A_C is reduced so as to maintain habitable and relatively comfortable (i.e., less humid) conditions for the one or more persons located within the enclosure chamber C_E. As with the first construction, the second construction treatment device 59 also preferably includes a sensor 67 configured to sense carbon dioxide within the enclosure air A_C and a controller 68 coupled with the sensor 67 and operatively connected with the fan 58. The controller

68 is configured to operate the fan 58 so as to maintain a level of carbon dioxide within the air A_C below a predetermined value, as discussed in further detail below, although the fan 58 may alternatively be continuously operated or manually controlled (i.e., switched on and off).

With the shelter system 10 described above, one or more persons are provided with a breathable atmosphere or air A_C which is substantially isolated from the external, environment air A_E and is sustainable for a prolonged period of time, such as for example, one or two weeks, a month or even longer. As such, the person(s) inhabiting the enclosure 12 are completely protected from exposure to any dangerous agents, i.e., hazardous chemicals, biological agents or radiological particles, that are suspended or dispersed within the environment air A_E surrounding or within the building B, the vehicle V, or other environment E in which the shelter system 10 is located. Having described above the basic elements of the safe room system 10 of the present invention, each of these and additional components and/or systems are described in further detail below.

Referring first to Figs. 1-7, with the building application or environment E, the building B may be a family or personal home (as depicted), but may alternatively be an apartment, an apartment building, a warehouse (Fig. 8), an office building, a store, a church, a public building (e.g., city hall, library, etc.) or any other structure inhabitable by one or more persons. The building B preferably has a plurality of rooms R_n, such as a master bedroom (e.g., room R_2 in Figs. 1 and 2), one or more bathrooms (e.g., room R_3 in Fig. 2), one or more additional bedrooms (e.g., room R_6 in Fig. 7), one or more closets (e.g., room R_2 in Fig. 2), an attic (e.g., room R_1 in Fig. 1), one or more hallways (e.g., room R_5 in Fig. 7), and a plurality of passages P (i.e., doorways or hallways) connecting the rooms R_1, R_2, etc. Further, the building B may include only a single floor or level L or may include two or more floors/levels L.

Referring now to Figs. 1-16, as discussed above, the enclosure 12 is preferably formed as an encloseable, multi-portion bag 13 that includes the preferred two or more enclosure sections 21A, 21B, etc., and is constructed of one or more relatively thin sheets 24 of a generally flexible material, as discussed in detail below. As such, the enclosure 12 is contractable from the deployed, usage configuration (Figs. 1-4, 7, 8, 12, 13) to a storage configuration (Figs. 5, 6 and 9) and alternatively expandable from the storage configuration to the deployed, usage configuration. More specifically, when the enclosure 12 is arranged in the deployed configuration, the enclosure first section 21A is disposed in the first room R_1, such as a basement (Fig. 1), attic (Fig. 3) or closet (Fig. 4), the enclosure

second section 21B is disposed in the second room R_2, the enclosure third section 21C is disposed in the third room R_3, etc. As shown in Fig. 5, when the enclosure 12 is arranged in the storage configuration, the enclosure bag 13 is substantially collapsed such that the first chamber section C_{S1}, the second chamber section C_{S2}, the third chamber section C_{S3}, etc., of the plurality of enclosure sections 21A, 21B, 21C, etc., each have a minimum volume. Most preferably, the outer chamber sections C_{S2}, C_{S3}, have substantially zero volume when disposed in the collapsed configuration and the "storage" enclosure chamber section C_{S1} has a minimum volume sufficient to contain the oxygen generator 14, air treatment device 16, associated supplies, food, water, a radio, television set, computer, etc., but may alternatively be collapsed so as to have substantially zero volume. As such, each enclosure section 21A, 21B, 21C is foldable into a separate package storable either separately within the associated room R_1, R_2, R_3, etc., or the entire enclosure 12 may alternatively be foldable into a single, relatively compact package disposeable within one room R of the building B, such as a closet (as depicted), attic or basement. In either case, the oxygen generator 14, the air treatment device 16 and other related items are storable within one or more sections 20 of the collapsed enclosure 12. Further, each enclosure section 20 is preferably generally shaped such that, when disposed in the usage configuration, the enclosure section shape corresponds with the shape of the particular room within which the section 20 is disposed, such as generally rectangular (e.g., sections 21A, 21B in Fig. 12) or generally triangular (e.g., section 21A in Fig. 3), or any other appropriate shape.

Referring to Figs. 4, 12 and 13, each enclosure section 20 preferably includes a generally horizontal base wall 70, a generally horizontal ceiling wall 72 spaced above the base wall 70, and a plurality of generally vertical side walls 74 extending between and integrally connecting the base and ceiling walls 70, 72, respectively. When disposed within the associated room R, the base wall 70 is disposed generally upon the floor R_F of the room R, the ceiling wall 74 is preferably disposeable generally against or proximal to the room ceiling R_C, and each side wall 74 is preferably disposed against or proximal to one of the room side walls R_S. Each wall 70, 72 and 74 has an inner surface 70a, 72a, and 74a that collectively bound the interior chamber section C_{Sn} of the particular enclosure section 20 and an outer surface 70b, 72b, and 74b. Further, each enclosure section 20 further includes at least one entry or passage opening 71 disposed within one of the side walls 74 and sized to permit a person to pass between the environment E and the enclosure chamber C_E or between adjacent enclosure sections 20 (e.g., 21A and 21B), as discussed

below. Each passage opening 71 is preferably generally rectangular and bounded by four edges 71a of the particular side wall 20, but may alternatively have any other appropriate shape, such as for example, generally circular and defined by a single enclosed edge surface (not shown).

Referring to Figs. 1-3, 7, 12 and 17, the multi-section enclosure 12 includes at least one connective portion 75 joining each pair of adjacent enclosure sections 20 and generally disposeable within the building passage P (i.e., doorway or hall) extending between the two associated rooms R. For example, one connective portion 75 integrally connects the first and second enclosure sections 21A, 21B and is disposed within the passage P_1 between the two rooms R_1, R_2 (see e.g., Fig. 2). Alternatively, if the enclosure 12 is intended to be used within only a single building room R or in an exterior environment E, such an enclosure 12 is formed of only a single enclosure section 20 without any connective portions (e.g., Figs. 8 and 13). Each connective portion 75 bounds an interior chamber section C_C and has opposing open ends 75a each connected with a separate passage 71 of two enclosure sections 20, such that the enclosure chamber C_E extends substantially continuously throughout the enclosure sections 20 and the connective portion 75. Further, each connective portion open end 75a is either disposed within one enclosure passage opening 71 or is attached to the enclosure wall surface(s) surrounding the passage edges 71a. Preferably, at least one connective portion end 75a is removably attached to the associated enclosure section 20 to enable disassembly of the enclosure 12 into each separate section 20. Further, the connective portion(s) 75 are each preferably formed as a generally rectangular tube or tubular section and each preferably has a base wall 77a, a ceiling wall 77b spaced above the base wall 77a and two sidewalls 77c extending between and integrally connecting the base and side walls 77a, 77b. However, the connective portions 75 may have any other appropriate shape, such as a generally circular tube or tubular section.

Preferably, the enclosure 12 further includes a plurality of connectors 76 disposed at various locations on the wall outer surfaces, particularly the ceiling wall outer surfaces 72b and the side wall outer surfaces 74a, that are configured to attach the enclosure walls 72, 74 (and possibly also the base walls 70) to proximal room walls, as discussed above. Most preferably, the connectors 76 are each a magnet or a metallic piece that is magnetically engageable with another magnet or metallic piece mounted on a proximal room wall R_C or R_S, such that each enclosure section 20 is removably attachable to the walls R_C, R_S of the associated room R. However, the connectors 76 may be any other type

of fastener element, such as for example, mating hook and loop piles (i.e., Velcro®), hooks, tape, magnets, etc., capable of removably or non-removably attaching the enclosure walls 72, 74 (and possibly base wall(s) 50) to the associated room R_n.

Alternatively or in addition to the connectors 76, each enclosure section 20 may be provided with one or more supports 78 configured to maintain the enclosure 12 disposed in the deployed, usage configuration. Each support 78 is either contactable with an interior surface 72a, 74a of the enclosure 12 or is connectable with an exterior surface 72b, 72b of the enclosure 12. In one construction, the one or more supports 78 are each a frame 80 formed of a plurality of interconnected elongated members 82, most preferably as a generally rectangular truss. Each frame 80 has an upper end 80a contactable with the inner surface 72a of an enclosure ceiling wall 72 and configured to maintain the wall 72 spaced above the base wall 70, as best shown in Fig. 8. Preferably, the support frames 80 are each collapseable from a deployed configuration (Fig. 8) to a storage configuration (Fig. 6), the frame 80 being configured to support the enclosure section 20 when the frame 80 is arranged in the deployed configuration. With this structure, the frame 80 is disposeable within the enclosure interior chamber C_E when the frame 80 is arranged in the storage configuration, such that the frame 80 is storable with the remainder of the shelter items, as discussed above and in further detail below. Referring specifically to Fig. 4, in another construction, each support 78 includes at least one elongated member or pole 84 having an upper end 84a and a lower end 84b. The pole lower end 84a is contactable with the enclosure base wall 70 and the upper end 84b is contactable with either the ceiling wall 72 or the side wall 74 so as to maintain the ceiling wall 72 spaced vertically above the base wall 70. The one or more poles 84 may be used individually, or two poles 84 may be joined with a horizontal cross member (not shown) so as to provide a greater contact area with the enclosure ceiling wall 72 or side wall 74.

Referring to Figs. 7 and 12, the enclosure 12 preferably further includes at least one door opening 86 providing access for persons to enter the shelter 10 and a door or cover 88 configured to substantially seal the opening 86 so as to maintain the enclosure air A_C isolated from the building atmosphere or air A_B. Most preferably, the shelter 10 further comprises at least one decontamination enclosure 90 connected with the enclosure 12 and bounding an interior chamber C_D, as best shown in Fig. 7. The decontamination enclosure 90 is preferably disposeable within at least one and preferably a plurality of the building rooms R_n. Further, the decontamination enclosure 90 has a first opening 92A extending between the decontamination chamber C_D and the interior space S_{Rn} of one of the building

rooms R_n not incorporated into the shelter 10 (or even space outside the building B) and a second opening 92B extending between the decontamination chamber C_D and the chamber section C_{S_n} of the connected enclosure section 20, which may also provide the enclosure door opening 86 and cover 88. Further, the decontamination enclosure 90 includes a first cover 94A configured to substantially seal the first opening 92A, so as to thereby prevent the building air A_B (or other external atmosphere/air A_E) from entering the decontamination interior space D_S, and a second cover 94B configured to substantially seal the second opening 92B so as to prevent any gases within the decontamination enclosure 90 from entering the main enclosure 12. Most preferably, the decontamination enclosure 90 includes a plurality of sections 91A, 91B, 91C, etc., each separated by a separate interior opening 92C, 92D, etc., each opening being separately sealable by a separate cover 94C, 94D, etc., so as to provide separate decontamination stages. Further, appropriate decontamination equipment, such as a sink F_1, a showerhead F_3, a bathtub F_5, cleaning chemicals (not shown), etc., are located within the decontamination enclosure 90 when the shelter 10 is deployed within the building B. As such, persons who have been exposed to chemical, biological and radiological agents can be decontaminated within the enclosure 90 prior to entering the main enclosure 12, so as to prevent contamination of the enclosure 12.

Referring to Figs. 9-11, with the vehicle application or environment, the vehicle V may be any appropriate vehicle, as mentioned above, and preferably includes at least one chamber C_V and may include a plurality of chambers (not shown). In one application depicted in Figs. 9 and 10, the vehicle V is a truck T having a rear compartment 96 providing the interior chamber V_C, the enclosure 12 being storable within the compartment 96. The compartment 96 has a floor 96a, a roof 96b spaced above the floor 96a, at least two and preferably three side walls 96c, and a hatch or door 98 controlling access to the compartment 96. The compartment walls 96a, 96b, 96c bound or define an interior space S_C within which the enclosure is at least partially disposeable, as discussed below.

As with building enclosure described above, the truck enclosure 12 is formed as a sealable or encloseable, multi-portion bag 13 constructed of one or more relatively thin sheets 24 of a generally flexible material so as to be expansible from a storage configuration (Fig. 9) to a usage configuration (Fig. 10), and vice-versa, as discussed above and in further detail below. Preferably, the enclosure 12 basically includes an interior section 21A disposeable within the compartment 96, at least one exterior section 21B, 21C, etc. (only one shown) disposeable within the environment E outside of the truck

T, and a decontamination enclosure 90 connected with one of the exterior sections 20 (e.g., section 21B). When in the deployed, usage configuration (Fig. 10), the interior enclosure section 21A provides a first interior chamber section C_{S1} and occupies at least a substantial portion of the compartment interior space S_C and the exterior enclosure section(s) 21B provide a potentially relatively large, second chamber section C_{S2} locatable within the surrounding environment E. Such an enclosure chamber section C_{S2} is beneficial for many potential applications, such as for example, establishing a command post, a medical treatment facility, or otherwise providing shelter for one or more persons.

Preferably, the truck enclosure 12 further includes a connective portion 75 extending between and connecting the first and second chamber sections 21A, 21B. Specifically, each enclosure section 21A, 21B has a passage opening 71 and the connective portion 75 has opposing open ends 75a each connected with a separate one of the two passage openings 71. Further, each truck enclosure section 21A, 21B is generally rectangular and has a base wall 70, a ceiling wall 72 and four side walls 74 extending between and integrally connecting the base and ceiling walls 70, 72. As the truck compartment 96 is spaced above the ground surface S, the base wall 70 of the interior enclosure section 21A is spaced vertically above the exterior section base wall 70, such that the connective portion 75 is generally angled or "sloped" between the two enclosure sections 21A, 21B. Further, the decontamination enclosure 90 is generally rectangular and includes a base wall 93, a ceiling wall 95 spaced above the base wall 93 and three side walls 97 extending between and integrally connecting the base and side walls 93, 95. The decontamination enclosure 90 further has a first opening 92A extending between the decontamination chamber C_D and the exterior environment E and a second opening 92B extending between the decontamination chamber C_D and the exterior enclosure section 21B. A first removable cover 94A is configured to substantially seal the first opening 92A and a second removably cover 94B is configured to substantially seal the second opening 92B, the two covers 94A, 94B preventing any gases from entering the enclosure chamber C_E. As discussed above, the decontamination enclosure 90 may be divided into a plurality of separated sections (not shown) to provide separate decontamination stages, and preferably includes decontamination equipment (e.g., chemicals, wash water, etc.) disposed within the chamber C_D.

Furthermore, the interior chamber section 21A preferably includes a plurality of connectors 76, preferably magnets, disposed at various locations on the ceiling and side wall outer surfaces 72a, 74a, to removably connect the enclosure walls 72, 74 to the

compartment roof 96b and sidewalls 96c, respectively. Additionally, the truck enclosure 12 also includes at least one and preferably a plurality of collapseable frames (not shown) disposeable within the exterior chamber section C_{S2} and each having an upper end contactable with the exterior section ceiling wall 72. As such, the frames retain the ceiling wall 72 spaced above the base wall 70, and thus maintaining the exterior enclosure section 21A disposed in the usage configuration. When the truck enclosure 12 is in the storage configuration, the two enclosure sections 21A and 21B and the decontamination enclosure 90 are stored within the vehicle compartment 96. Further, the oxygen generator 14, the air treatment device 16, the frames, all supplies (food, water, etc.) and any other equipment desired to be used in the enclosure (e.g., radios, desks, patient beds, or operating tables, etc.) are stored within the chamber section CS1 of the collapsed or deployed enclosure interior section 21A.

Referring to Fig. 11, in another exemplary application, the vehicle V is an aircraft A including one or more compartments 100 providing the interior chamber V_C, the compartment 100 having a floor 100a, a roof 100b, four side walls 100c, and a hatch or door 102 controlling access to the compartment 100. The compartment walls 100a, 100b, 100c define an interior space S_C within which the aircraft enclosure 12 is at least partially disposeable. The enclosure 12 is preferably formed as an encloseable bag 13 constructed of one or more flexible material sheets 24, such that the enclosure 12 may be expansible from a storage configuration (not shown) to a usage configuration (as depicted), and vice-versa. The enclosure 12 preferably includes a single, generally rectangular section 20 having a base wall 70, a ceiling wall 72 and four side walls 74 extending between and integrally connecting the base and ceiling walls 70, 72, the four walls 70, 72, 74 defining the enclosure interior chamber C_E. At least one door opening 86 is provided in one side wall 74 (or base wall 70 or ceiling wall 72) and extends between the enclosure chamber C_E and the exterior environment E, and the enclosure 12 includes at least one removable cover 88 configured to substantially seal the door opening 86 to prevent gas entry into, or egress from, the enclosure chamber C_E. Further, the aircraft enclosure 12 may be provided with a decontamination enclosure (not shown) disposeable either within the compartment 100, another compartment of the aircraft A or within the exterior environment E (i.e., for use on the ground), in which case the door/passage opening 86 is connected with the decontamination chamber (not shown).

Furthermore, the aircraft enclosure 12 preferably includes a plurality of connectors 76, preferably magnets, disposed at various locations on the ceiling and side wall outer

surfaces 72a, 74a, to removably connect the enclosure walls 72, 74 to the aircraft compartment roof 100b and side walls 100c, respectively, when the enclosure 12 is disposed in the usage configuration. Alternatively or additionally, the enclosure 12 may include one or more collapseable frames (none shown) disposeable within the enclosure chamber C_E and each having an upper end contactable with the ceiling wall 72 to maintain the ceiling wall 72 spaced above the base wall 70. Further, the oxygen generator 14, the air treatment device 16, the frame(s) 80, all supplies (food, water, etc.) and any other equipment desired to be used in the enclosure (e.g., radios, desks, patient beds, or operating tables, etc.) are stored within the enclosure chamber 12 collapsed or deployed enclosure interior section 21A. In addition to being useable as a safe environment for isolating persons from dangerous agents, the aircraft enclosure 12 may alternatively be used to transport exposed persons to a safe location, while preventing the substances on the exposed persons from escaping or leaking out of the enclosure chamber C_E.

Referring to Figs. 19 and 20, the enclosure bag 13 is preferably formed of at least one sheet 25A of a first material, the first material sheet(s) 25A generally providing air impermeability and structural integrity to the enclosure 12, and at least one sheet 25B of a second material, the second material sheet(s) 25B being at least generally light transmissive. Each first material sheet 25A preferably includes at least one layer of a metallic or metallized substance, such that the first sheet(s) 25A provide a substantial amount of air impermeability, and at least one layer of a relatively easily meltable or fuseable material to enable connection with other material sheet 25A and/or 25B. Further, each second material sheet 25B provides a window 27 for a person(s) located within the enclosure 12 to view external surroundings thereof, as the first material sheet(s) 25A are preferably generally opaque. Preferably, the one or more windows 27 are located with respect to the remainder of the enclosure 12 such that the enclosure windows 27 are located adjacent to windows (none shown) of the building B or in a door or cover 88 of the enclosure 12. However, the enclosure bag 13 may alternatively be constructed without any windows, such that the enclosure 12 is formed entirely of one or more first material sheets 25A.

As indicated in Fig. 19, each first material sheet 25A is most preferably a laminate formed of multiple layers of various different materials. The multiple layers of various different materials provide at least the following properties for the enclosure 12: a barrier to gases and vapors, puncture and tear resistance, and an outer layer that is heat sealable to another first material sheet 25A, to a second material sheet 25B, or a portion/piece of

either type of sheet 25A, 25B. More specifically, each first material sheet 25 most preferably consists of the following nine layers: a first, outer layer 110A is formed of Surlyn (manufactured by EI Dupont De Nemours and Company of Wilmington, DE), a second, inner layer 110B is an adhesive, a third, inner layer 110C is formed of Biax Nylon, a fourth, inner layer 110D is an adhesive, and a fifth, inner layer 110E is formed of a metal foil, preferably aluminum foil, a sixth, inner layer 110F is an adhesive, a seventh, inner layer 110G is formed of Valeron (manufactured by Valeron Strength Films of Houston, TX), an eighth, inner layer 110H is an adhesive, and a ninth, outer layer 110I is formed of Surlyn.

An alternative structure of the first material sheet(s) 25A is a nine layer structure (not shown) consisting of a first, outer layer of linear low density polyethylene, a second, inner layer of adhesive, a third, inner layer of Valeron a fourth, inner layer of adhesive a fifth, inner layer of a metal foil or metallized substance, a sixth, inner layer is an adhesive, a seventh, inner layer formed of Valeron, an eighth, inner layer of adhesive, and a ninth, outer layer of liner low density polyethylene.

More specifically, the metal foil layer 110C is most preferably aluminum foil that is approximately 0.00035 inches thick and provides air impermeability. The Surlyn layers 110A, 110I are preferably each about two mils thick and provide a sealing layer. Specifically, the Surlyn layers 110A, 110I function to fuse with a corresponding layer 110A or 110I of another sheet 25A or 25B along a seam line 111 to form a joint 113, which may be single-overlapping (as shown), double–overlapping (as shown), or formed in any other appropriate manner. The Biax Nylon layer 110E is preferably sixty gage, and the Valeron layer 110G is preferably about three mils thick, the two layers 110E, 110G both providing strength and puncture resistance. Further, the four adhesive layers 110B, 110D, 110F and 110H each function to bond together the other five layers 110A, 110C, 110E, 110G, and 110I. Preferably, the first sheets 25A are each of a total thickness T_1 of about 8 mils (0.008 inches) as indicated in Fig. 19, such that the formed enclosure 12 is substantially flexible. Further, although the metal foil layer 110C is presently preferred it could be replaced by a metallized polyester layer, or of any other appropriate material capable of providing substantial air impermeability to the material sheet(s) 25A. Also, the two outer layers of surlyn could be replaced by two layers of Saranex manufactured by the Dow Chemical Company of Midland, MI.

Referring to Fig. 20, each second material 25B is most preferably formed of a laminate of seven material layers, specifically a first, outer layer 114A of Surlyn, a second,

inner layer 114B is an adhesive, a third, inner layer 114C is formed of HD Polyester, a fourth, inner layer 114D is an adhesive, a fifth, inner layer 114E is formed of clear Valeron, a sixth, inner layer 114F is an adhesive, and the seventh, outer layer 114G is formed of Surlyn. The Surlyn layers 114A and 114E are used to attach the sheet 25B with other sheets 25B or 25A by means of melting/fusion along a seam line 115, preferably to form a single overlap joint 116 as shown in Fig. 20, and the adhesive layers 114B, 114D, 114F function to bond together the other layers 114A, 114C and 114E. Furthermore, the clear Valeron layer 114E provides tear strength and puncture resistance. Additionally, the second sheets 25B are each preferably of a thickness T_2 of about 9 mils. (0.009 inches) as indicated in Fig. 20. With the preferred thickness T_1, T_2 being relatively minimal, particularity in comparison with the over all size of the walls 70, 72, 74 of the enclosure 12, the enclosure 12 is substantially flexible such that shelter 10 may be collapsed to the storage configuration as discussed above.

Furthermore, each of the first and second material sheets 25A, 25B is preferably provided in the form of one or more rolls of material (not shown) of a relatively substantial length, preferably of about five hundred feet (500') in length, and having a width of about (60"). An enclosure fabricator calculates the number of material sheets 24 (i.e., sheets 25A and possibly sheets 25B) required to enclose each of the buildings rooms R that are desired to be incorporated into the shelter 10. Then, the required number of material sheets 24 are cut or otherwise detached from the roll and are shaped to form the desired shape of each enclosure section 20. Preferably, the first material sheets 25A are sized and shaped first, the door opening(s) and the openings 29 for the windows 27 being provided therein (e.g., cut or punched). Then the first material sheets 25A are each attached to the other sheets 25A, preferably by applying heat (e.g., ironing) to each pair of overlapping sheet edges 23 so as to melt or fuse the sheet edges 23 into an air impermeable seam or joint 113 or 116. Preferably, all of the first material sheets 25A for each room or compartment of the shelter 12 are attached together to form an enclosure section or "shell" 120 for that room or compartment, in other words, without the windows 27 and the door covers 88. Thereafter, the second material sheets 25B are cut or otherwise shaped to fit within each window opening 29, if any windows are desired, and the edges 23 of each second sheet 25 are attached to one or more first sheets 25A so as to cover the window openings 29 and form the window(s) 27.

Referring to Figs. 1, 3, 6, 17 and 18, the multi-section enclosure 12 preferably further includes one or more connective inserts 122 that either provide a connective

portion 75 for joining two adjacent enclosure sections 20, as described above, or are used to attach a connective portion 75 to another enclosure section 20. The inserts 122 are preferably formed one or more first material sheets 25A and each includes a generally rectangular tube or tubular central band 121 and at least one and preferably two generally rectangular flange ends 123. With a doorway application as best shown in 17 and 18, the tubular band 121 is disposeable within the doorway D, while three vertical sections of each flange end 123a are disposed about the doorway perimeter and one horizontal flange section 123b is disposed upon the room floor R_F. Preferably, one flange end 123 is permanently attached (i.e., melted or fused) to the passage opening 71 of one enclosure section 20 and the other, "free" end 123 is removably connectable to the passage opening 71 of the adjacent enclosure section 20, preferably by means of one or more strips of a connective sealant material 125 (e.g., duct tape). As such, the two adjacent enclosure sections 20 may be separately disposed in adjacent rooms R, then removably connected together by attaching the free flange end 123 to the other enclosure section 20. Alternatively, the connective inserts 122 may be removably or permanently attached to both adjacent enclosure sections 20.

Although the above material sheets 25A, 25B are preferred, it is within the scope of the present invention to form the enclosure 12 out of any other appropriate material, either formed as laminates of different materials or of a single material, and either as different material sheets or only a single type of sheet or even a single sheet or shell, as long as the formed enclosure 12 is sufficiently air impermeable to prevent fluid communication between the enclosure air A_C and the building air A_B and/or other environment air A_E.

Referring now to Fig. 21, the housing 26 of the oxygen generator 14 preferably includes a base wall 130 and an enclosed sidewall 132 having a lower end 132a attached to the base wall 130 and an upper end 132b forming the housing opening 32. The base wall 130a has an upper surface 130a and the sidewall 132 has an inner circumferential surface 132a, the two wall surfaces 130a, 132a defining the housing chamber 30. Most preferably, the housing 26 is provided by a commercially available cylindrical drum having a capacity of about eighteen gallons, but may be a specially manufactured housing or/and formed in any other appropriate manner.

As discussed above, the oxygen-producing material 28 is preferably a granular mass of sodium percarbonate, but may alternatively be another appropriate material such as hydrogen peroxide, a source of hydrogen peroxide, a percarbonate salt, a perborate salt,

a persulfate, sodium pyrophosphate peroxyhydrate, urea peroxyhydrate, sodium peroxide, a peracid or another organic peroxide, or a source of peracid. The preferred oxygen-producing material 28 is preferably coated with another material that is configured to retain active oxygen within the oxygen-producing material 28 and to prevent caking thereof. Preferably, the coating material is silica, but may alternatively be borate, a water soluble surfactant, or any other coating including boron or magnesium or mixtures thereof, or any other appropriate material.

Further, as discussed above, a supply 31 of the oxygen-producing material 28 is preferably stored externally of the generator housing 26, most preferably within one or more containers 134, such as a storage bag 135 (one shown). Preferably, the material supply 31 has a total mass, about seventy-two pounds for each person in the shelter 10, sufficient to replenish the quantity of oxygen-producing material within the housing chamber 30 at least predetermined number of times, about six times, so that the percentage of oxygen within the enclosure air is maintained above the minimum value of 20% for at least a predetermined period of time, preferably at least seventy-two hours.

When it is desired to generate oxygen, either after expiration of a predetermined time period or when a low level of oxygen is detected, a person within the enclosure 12 preferably adds a quantity of the catalyst material 36 to a quantity of the water 35. As discussed above, the catalyst material 36 is preferably manganese acetate tetrahydrate, but may be any other appropriate material, such as for example, iron-tetra amido macrocylic ligand, magnesium dioxide, or cellulase. Most preferably, the preferred catalyst material 36 is added to the preferred chemical reaction initiating material 34 in a ratio of one-quarter ounce of manganese acetate tetrahydrate to each one gallon of water 35.

The person then pours a predetermined quantity of the water 35 and catalyst material 36, preferably about one or two gallons of water 35, into housing opening 32 and into the chamber 30. Next, the person removes a quantity of the oxygen-producing material 28, preferably about six pounds, from the supply 31, most preferably by merely handling one of the storage bags 135. Then, the person places or pours the material 28 into housing opening 32 such that the material enters the interior chamber 30. Once the oxygen-producing material 28 contacts the water 35 and catalyst material 36, the material 28 begins reacting and generating oxygen, which flows out of the chamber 30, through the housing opening 32 and into the enclosure chamber E_C. The preferred percarbonate material 28 is preferably added to the water 35 and catalyst material 36 in a ratio of about

twelve pounds of oxygen-producing material to each gallon of the mixture of water 35 and catalyst material 36.

Further, the oxygen-producing material 28 produces a waste byproduct 136, in the form of a sludge, that is removable from the housing 26 when the entire quantity of material 28 has reacted. Such waste product removal should be performed, preferably by tilting the housing 26 to enable the product 136 to flow out of the opening 32 and into a waste container (not shown) to evacuate the housing chamber 30 to enable another quantity of oxygen-producing material 28 to be disposed or placed within the housing chamber 30.

Referring now to Figs. 22-25, an alternative oxygen generator 14 basically includes a chemical oxygen generation device 140 configured to generate oxygen and an emitter device 142 configured to controllably emit or discharge the oxygen into the enclosure 12 or another enclosed room (none shown). The chemical oxygen generation device 140 preferably includes a chemical compound that generates oxygen through a chemical reaction of thermal decomposition, and is most preferably a chlorate system element or "chlorate candle" 144, but may be other appropriate chemical devices as discussed below. The oxygen candle 144 is basically includes an alkali metal chlorate, preferably sodium chlorate ($NaClO_3$), and subsidiary agents such as an exothermic or igniter agent and a chlorine absorbent, the chemical compounds being disposed within a generally cylindrical container 145 so as to be generally shaped as a candle, as discussed in further detail below. The emitter device 142 includes a housing 148 configured to receive the oxygen generation device 140, preferably the oxygen candle 144, and having an interior chamber 146 configured to retain oxygen generated by the device 140. A discharge port 150 is fluidly connected with the interior chamber 146 and is configured to discharge oxygen from the chamber 146 to the enclosure interior space S_E in a generally continuous flow F_{O2} while the device 140 generates oxygen, although the flow F_{O2} is preferably interruptible so as to control the oxygen content within the enclosure atmosphere A_E, as discussed below.

The chemical oxygen generation device 140 is preferably an oxygen candle 144 formed of a chlorate material, most preferably sodium chlorate ($NaClO_3$). The oxygen candle 144 preferably further includes an igniter device 143, such as an ignition match (not shown), disposed on the upper end of the container 145 and configured to ignite the chlorate material. Once ignited, the chlorate material continues to consume itself by means of an exothermic chemical reaction so as to release substantial quantities of oxygen. Alternatively, the oxygen candle 144 may be formed of another similar type of material

(e.g., lithium perchlorate, etc.). Further, the oxygen generation device 140 may be formed of another oxygen generating chemical, such as for example, potassium superoxide, that generates or releases oxygen with the addition of another chemical (e.g., water) or by any other type of chemical process.

The preferred oxygen candle 144 is relatively large and has a diameter of about six and one-quarter inches (6-1/4") and a height of about eleven and one-half inches (11-1/2") and contains sufficient chlorate material to generates oxygen at a rate of about sixty-six (66) liters/min for about fifty (50) minutes, and thus generates a total volume of about thirty-three hundred (3,300) liters of oxygen. Most preferably, the candle 144 is a part number 85984 chlorate candle available from Mine Safety Appliances (MSA) of Pittsburgh, Pennsylvania. If the oxygen generated by the preferred candle 144 is released directly into the enclosure 12, the percentage of oxygen in the enclosure air A_C would quickly rise above a level at which the enclosure air A_C becomes potentially flammable, generally over twenty-three point five percent (23.5%) oxygen, and will likely eventually rise to a level at which the atmosphere A_E may become toxic to humans, generally over 50% oxygen. In other words, at higher levels of oxygen for a prolonged period of time (e.g., three days, one week, etc.), humans generally develop negative health issues, including negative pulmonary effects, such as diminished lung capacity and other breathing maladies, and central nervous system issues that may lead to seizures. Therefore, the oxygen generator 14 preferably includes the emitter device 142, as described above and in further detail below, which functions to release the oxygen generated by the candle 144 into the enclosure atmosphere A_E at much lower rate than the rate at which the candle 144 generates oxygen. More specifically, the emitter device 142 is configured to controllably release the oxygen generated by the candle 144 to maintain the percentage of oxygen in the enclosure atmosphere A_E generally at a preferred level of about 20.9%.

Still referring to Figs. 22-25, as discussed above, the emitter device 142 basically includes a housing 148 with an interior chamber 146 and a discharge port 150 configured to discharge oxygen from the chamber 146 and into the enclosure interior chamber C_E. The discharge port 150 empties the chamber 146 of oxygen a rate which is substantially lesser than the rate of sixty-six (66) liters/minute at which the preferred oxygen candle 144 fills the chamber 146, preferably between about one-half (0.5) liters/minute/person within the enclosure 12 and about one (1) liter/minute/person. Further, the discharge port 150 is configured to discharge oxygen into the room(s) R_n at the desired flow rate so as to

maintain a portion or percentage of oxygen within the atmosphere at a value generally between a predetermined minimum value, preferably about twenty percent (20%) and a predetermined maximum value, preferably about twenty-two percent (22%), as discussed below. Preferably, the emitter device 142 further comprises a valve 154 configured to regulate flow through the discharge port 150, in which case the discharge port 150 is thereby being provided by the integral, obstructable port of the valve 154. Most preferably, the valve 154 is adjustable so as to discharge oxygen from the port 150 at a variable flow rate, as discussed in further detail below. However, the discharge port 150 may be provided by a nozzle or other non-obstructable porting device (none shown) mounted to the housing 148 or even an appropriately sized orifice extending directly through the walls of the housing 148, such that the emitter device 142 is formed without any valve or other means to vary the oxygen flow rate.

Preferably, the emitter housing 148 includes a generally cylindrical, generally enclosed shell or tank 156 bounding the interior chamber 146 and a base 157 configured to support the tank 156. The housing tank 156 is preferably formed as a pressure vessel capable of withstanding or "rated" for fluid pressures of at least two hundred (200) pounds per square inches (psi) and is preferably sized to contain at least eighty (80) gallons of fluid at the two hundred psi rating. The base 157 is preferably formed as a cylindrical wall or rim 159 attached to the tank lower end wall 158B, as depicted in Figs. 24 and 25, but may be formed as a plurality of separate legs 161, as shown in Fig. 22. Preferably, the housing tank 156 has upper and lower, partly spherical or hemispherical end walls 158A, 158B, respectively, and a tubular side wall 160 extending between and integrally connecting the two end walls 158, 158B. At least one and preferably two access openings 162A, 162B extend through the side wall 160 and located so as provide access to the candle 144, for reasons discussed below, and two doors 164 each releasably engageable with a separate one of the openings 162A, 162B so as to seal the openings when the chamber 146 contains oxygen. Further, the tank 156 preferably further includes a plurality of threaded openings 166 extending through the tank side wall 160, each opening 166 fluidly connecting the interior chamber 146 with a separate flow device, as discussed below.

Preferably, the emitter device 142 further comprises a holder 168 disposed within the housing interior chamber 146 and configured to releasably retain at least one candle 144. The holder 168 preferably includes a cylindrical base 170 disposed upon the housing lower end wall 158B and sized to receive and retain the lower end of the candle 144, and

at least one and preferably two guide rings 176 connected with the base 170 by a plurality of vertical rods 178. The rings 176 are sized so as to guide a candle 144 into the base 170 and also function to support the candle 144 when disposed within the holder 168. Further, the emitter device 142 preferably includes a chute 174 having a first, upper end 175a attached to the inner surface of the tank side wall 160 beneath the upper access opening 172A and a second, lower end 175b located proximal to the upper guide ring 176. As such, a candle 144 may be installed into the holder 168 inserting the candle 144 through the upper access opening 172A, guiding the candle 144 down the chute 174 and into the upper guide ring 176, and then allowing the candle 144 to slide down into the holder base 170. Preferably, a person installing a candle 144 into the holder 168 inserts one of their arms through the lower access opening 172B in order to better guide the candle 144 into the holder 168. Further, to ignite the candle 144, a person inserts one arm through the upper access opening 172A and then activates the igniter 143, such as by striking the igniter 143 with a hammer (not shown), such that the candle 144 begins to generate oxygen. The person then withdraws their arm and seals the upper access opening 172A with the associated door 164.

Referring to Figs. 22 and 23, the emitter device 142 preferably further includes a flow line 180, preferably provided by a generally rigid pipe, having a first end 181A connected with one opening 166, so as to fluidly connect the line 180 with the housing interior chamber 146 and a second end 181B spaced from the housing 148. With this structure, the valve 154 is attached to the flow line second end 181B so as to be fluidly connected with the interior chamber 146 through the flow line 180. Preferably, the valve 154 is a first, manually adjustable valve, most preferably a gate valve but may be any other appropriate valve such as a ball valve, spindle valve, etc. In addition, the emitter device 142 preferably further comprises a second, automatically adjustable valve 182 configured to regulate flow through the discharge port 150 in conjunction with the first valve 154, as depicted in Fig. 23. More specifically, the second valve 182 is preferably a solenoid valve, most preferably a "latching" solenoid valve, which includes a spindle and a solenoid 183 and is attached to the outlet of the first valve 154. As such, when the solenoid valve 182 is open, oxygen flows from the housing chamber 146 through the flow line 180, passes through the discharge port 150 in the first manual valve 154 and then flows through the second, solenoid valve 182. However, when the solenoid valve 182 is closed, flow is prevented through the discharge port 150, such that oxygen within the housing chamber 146 is retained therein. Further, a flow meter 183 is preferably connected with the outlet

of the solenoid valve 182 so as to provide flow rate information to a person operating the oxygen generator 14, such that the person is able to adjust the first manual valve 154 to provide a desired flow rate (i.e., when the solenoid valve 182 is open) through the discharge port 150.

Preferably, the emitter device 142 further comprises a sensor 184 configured to sense the percentage of oxygen within the enclosure atmosphere A_E and a control 186 coupled with the sensor 184 and with the solenoid valve 182. The control 186 is configured to automatically adjust the solenoid valve 182 to decrease the oxygen flow rate, preferably to about zero, when the sensed oxygen percentage is above a desired maximum value, preferably about twenty-two percent (22%). More specifically, the control 186 is configured to actuate the solenoid 182 so as to close the valve 182 when the sensed oxygen percentage within the enclosure atmosphere A_E is above the maximum value. In addition, the control 186 is also preferably further configured to open the solenoid valve 182 when the sensed oxygen percentage is below a desired minimum value, preferably about twenty percent (20%). As such, the control 186 functions to generally maintain the oxygen composition within the enclosure atmosphere generally about the percentages in normal atmospheric conditions so as to contribute to the comfort and health of the persons located within the enclosure 12.

Referring particularly to Fig. 23, the oxygen generator 14 preferably further comprises a distributor system 188 fluidly connected with the emitter device 142 and configured to disperse the oxygen discharged from the port 150 at desired locations in the enclosure 12. The distributor system 188 includes a flow line 190 fluidly connected with the emitter discharge port 150 and an air manifold 192 located distally from the emitter housing 148. The flow line 190 is preferably formed as a generally flexible, elongated tube 191 having a first end 191a fluidly connected with the discharge port 150, and preferably attached to the outlet of the flow meter 193, and a second end 191b connected with the manifold 192. The manifold 192 is preferably formed as an elongated tubular body 196 having a first, open end 196a, a second, closed end 95b and a plurality of outlet ports 198 spaced apart generally axially between the two ends 196a, 196b. The flow line second end 191b is attached to the manifold inlet end 196a, such that oxygen discharged from the port 150 flows through the flow line 190, into the manifold 192 and is dispersed through the plurality of outlet ports 198. The manifold 192 is disposed at a desired location with the enclosure 12 such that oxygen flows initially to the desired location, such as a master bedroom or a living room. By providing the distributor system 188, the

oxygen generator 14 may be disposed in one section 20 of the enclosure 12, e.g., located within a storage closet or basement, and the manifold 192 disposed in another enclosure section 20, for example located within a master bedroom or living room.

Referring now to Fig. 22 the emitter device 142 preferably further comprises a pressure relief valve 200 fluidly connected with the housing interior chamber 146 and configured to discharge oxygen from the chamber 146 when the pressure of the oxygen within the chamber exceeds a predetermined value, preferably two hundred pounds/square inch (200 psi). The pressure relief valve 200 preferably has connective portion 202 threadably connected with one of the threaded openings 166 in the emitter tank 156. Preferably, the emitter device 142 also includes a pressure gage 204 threadably attached to one of the tank threaded openings 166 and fluidly connected with the emitter interior chamber 146 so as to provide measurements of the oxygen pressure within the chamber 146. Further, an inlet or fill port 206 is fluidly connected with the housing chamber 146, the fill port 206 (and the discharge port 150) being obstructable such that the housing chamber 146 is configured to store an initial quantity of air. More specifically, the fill port 206 enables the housing chamber 146 to be filled with an initial quantity of gas, preferably compressed air, such that the gas is useable to "inflate" or provide an initial over-pressurization of the enclosure 12 during the expansion of the enclosure 12 to the deployed configuration as discussed above and in further detail below. Preferably, the inlet port 206 is provided by a check valve 208 threadably connected with one of the threaded openings 166 and a stem nozzle 210 attached to the check valve 208 and configured to connect with a source of compressed air (not shown). With this structure, compressed air form the air source enters through the stem nozzle 210, passes through the one-way check valve 208 and flows into the interior chamber 146.

Referring now to Fig. 26, the housing 40 of the first preferred construction 39 of the air treatment device 16 preferably includes a generally cylindrical body 220 having a generally horizontal bottom wall 222 and a generally tubular side wall 224. The side wall 224 extends generally vertically upwardly from the bottom wall 222 and has an upper open end 224a defining the second unit outlet port 44. The bottom wall 222 has an upper surface 222a and the side wall 224 has an inner circumferential surface 224a, the two wall surfaces 222a, 224a defining the housing chamber 17. Further, the side wall 224 preferably has an opening 225 formed therewithin (e.g., cut, punched, drilled) which provides the inlet port 42, although the port 42 may be alternatively provided in the bottom wall 222. Preferably, the housing 40 is provided by a commercially available, generally

cylindrical drum 126, but may be specially manufactured and/or formed in any other appropriate structure. Furthermore, the housing preferably also includes a support member 228 disposed within the housing chamber 17 so as to divide the chamber 17 into a lower chamber section 17a and an upper chamber section 17b.

More specifically, the support member 228 is spaced vertically above, and extends generally parallel with, the housing bottom wall 222. Preferably, the inlet port 42 is directly fluidly connected with the lower chamber section 17a and the outlet port 44 is directly fluidly connected with the upper chamber section 17b. Furthermore, the support member 228 has an upper surface 228a for supporting the reactive material 18, an opposing lower surface 228b, and at least one and preferably a plurality of flow passages 230. Each flow passage 230 extends between the upper and lower surfaces 228a, 228b and fluidly connects the upper and lower chamber sections 17a, 17b, as discussed below. Preferably, the support member 228 includes or is provided by a generally circular plate or screen 232 having a plurality of through-holes each providing a separate flow passage 230. The support member plate 232 is retained spaced above the wall 222 by friction or interference between the plate outer edge 232a and the side wall inner surface 224a, but may be retained in position by any other appropriate means, such as brackets, fasteners, one or more ledges, etc.

Further, the first construction treatment device 39 also includes an elongated fluid channeling member 236 fluidly connected with the housing inlet 42. The channeling member 236 is configured to channel into the housing chamber 17 enclosure air portions F_{AC} from a location(s) spaced from the outlet port 44, so as to avoid reprocessing treated air portions F_{AC}. The channeling member 236 has an outlet 236a fluidly connected with the inlet port 42 and an inlet 236b spaced from the housing 40. The fluid channeling member 236 is preferably a generally flexible tube or hose, but may be provided by any other appropriate device (e.g., a rigid pipe).

Still referring to Fig. 26, the fan 46 is preferably connected with the housing 40, and is most preferably generally disposed within or attached adjacent to the inlet port 42. Alternatively, the fan 46 may be disposed at any other appropriate location, such as within the channeling member 236, within the interior chamber 17 or in the outlet port 44. Preferably, the fan 46 is electric-powered, such that the air treatment device 16 further comprises a power supply 234 configured to provide electrical power to the fan 46. Preferably, the power supply 234 includes at least one battery 236 or battery pack, and one or more electric lines 238 operatively connecting the battery 236 with the fan 46.

However, the power supply 234 may alternatively be provided by any other source, such as an electric outlet P_B (and associated power network) located in the environment E and coupled with the fan 46 through a connector unit 400, as described below. Further, the fan 46 is preferably a commercially available fan, most preferably a Model 595DH fan from ETRI/Rosenberg USA of Monroe, Texas or a Model A34148 fan from Nidec America Corporation of Torrington, Connecticut, but may be any other appropriate available fan or even a specially manufactured device.

Further, the carbon-dioxide sensor 47 is configured to continuously sense or monitor the level or percentage of carbon dioxide within the enclosure air A_C. Preferably, the sensor 47 has an indicator or read-out configured to provide information corresponding to the carbon-dioxide level, such as for example, an LCD screen providing the carbon dioxide level in parts per million or percentage in the enclosure air A_C. Preferably, the sensor 47 is provided by a carbon-dioxide monitoring device 240, most preferably a commercially available TR9500 CO_2 Sensor from Airtest Technologies Inc. of Delta, British Columbia, Canada, but may be provided by any other appropriate carbon-dioxide sensor or sensing device. With the preferred monitoring device 240 also has an alarm unit (not shown), such as a horn or light, configured to provide an audible or visual alarm when the carbon-dioxide level reaches a predetermined limit, such as for example five thousand, eight hundred parts per million (5,800 ppm).

Furthermore, the controller 48 is coupled with the sensor 47 and is configured to activate the fan 46 when the sensed carbon-dioxide level is above a predetermined value or level, for example, five thousand parts per million. The controller 48 is further configured to deactivate the fan 46 when the carbon-dioxide level is below a predetermined level, for example fifteen hundred (1500) parts per million. More specifically, the controller 48 is preferably electrically coupled with the fan 46, either directly or through the power supply 234 (e.g., battery 236), and is configured to electrically couple the fan 46 to the power supply 234 and to alternatively decouple or disconnect the fan 46 from the supply 234. The controller 48 may be any other appropriate device capable of controllably operating the fan 46 in response to the sensed carbon dioxide level, such as for example, a microprocessor or a PLC.

Still referring to Fig. 26, the reactive material 18 is preferably a carbon-dioxide absorbent configured to absorb the carbon dioxide into the material 18 upon contact. As such, carbon dioxide is thereby removed from the enclosure air portions F_{AC} flowing through the housing chamber 17. The reactive material 18 is a preferably in the form of a

granular mass and is refillably disposed within the housing chamber 17 by filling or pouring the mass of granules into the housing outlet port 44. The granules of reactive material 18 fall upon the support member 228 and accumulates within the chamber 17 until the material mass reaches a particular height H_M above the screen member 228. The height H_M of the material mass is particularly critical to the functioning of the removal device 16 due to the fact that, if the material height H_M exceeds a certain value, depending on the size or capacity of the fan 46 and the volume of the housing chamber 17, the resistance to flow will create an excessive backpressure on the fan 46, which may reach the point that the fan 46 will be unable to rotate and thus unable to initiate air flow through the material 18. Alternatively, the reactive material 18 may be provided in any other appropriate form, such as a solid mass of foam (not shown).

Preferably, the reactive material 18 is a carbon-dioxide absorbent containing an alkali hydroxide, such as calcium hydroxide, sodium hydroxide, etc., and is most preferably SodaSorb® HP Indicating manufactured by the W.R. Grace company. Being SodaSorb®, the reactive material 18 changes color from white to purple when the capacity of the material 18 to absorb carbon-dioxide is exhausted. As such, at least one person inhabiting the enclosure 12 should monitor the material 18 and periodically remove the exhausted material and pour in "fresh" material form a source, such as a bucket or barrel (none shown) filled with the material 18. Although the SodaSorb® is preferred, the reactive material 18 may be any other appropriate carbon dioxide absorbent or even another type of material configured to react with and remove carbon dioxide from air. Furthermore, the reactive material 18 is mixed with a certain amount of an odor absorbent material, most preferably Purafill® (not indicated), such that odors are also removed from the air flow when the flow passes through the chamber 17.

With the structure as described above, the first preferred construction 39 of the air treatment device 16 basically functions as follows. When the carbon dioxide level in the enclosure air A_C reaches a certain level, preferably as determined by the monitoring device 240, the controller 48 activates the fan 46 or if no controller is provided, a person in the enclosure 12 uses a switch or other means to activate the fan 46. The operating or "rotating" fan 46 causes a portion F_{AC} of the enclosure air A_C to be drawn into the channeling member inlet 236b or directly into the inlet port 42 if no channeling member is provided. The air portion flow F_{AC} passes through the channeling member 236, through the fan blades 46a and into the housing inlet port 42. The air flow F_{AC} enters the lower chamber section 17a, passes through the support member passages 230 and flows through

the mass of reactive material 18 within the upper chamber section 17a. At least a portion of the carbon dioxide within the air flow F_{AC} reacts with the granules of reactive material 18 and is removed thereby. The "treated" air flow portion F_{AC}, having a substantially reduced carbon-dioxide content, flows out of housing outlet port 44 and mixes back with a remainder of the enclosure air A_C. Preferably, when the overall carbon dioxide level in the enclosure air A_E is reduced below a certain level, the controller 48 deactivates or "turns off" the fan 46 by decoupling the fan from the power supply, or a person may manually turn off the fan 46. Such intermittent operation of the fan 46 is preferred to conserve energy, particularly when the power supply 234 is one or more batteries, but the fan 46 may alternatively be in constant operation.

Referring now to Fig. 27, the second preferred construction air treatment device 59 includes the two removal units 50, 54, each having a different reactive material 52, 56, respectively, as discussed above. The second construction treatment device 59 is essentially the first construction device 39 with the addition of the first removal unit 50, preferably used to provide the additional capability of water removal or "dehumidification". As such, the structural details of the second removal unit 54 are substantially identical to the first construction treatment device 39 discussed above, so that the following description primarily focuses on the details of the first removal unit 50.

The first removal unit 50 includes a housing 250 with a cavity 252 providing the interior chamber 60 and an outer surface 250a, the inlet port 62 and outlet port 64 extending between the unit housing outer surface 250a and the housing cavity 252. Preferably, the housing 250 includes a generally enclosed, generally cylindrical body 254 having a generally horizontal bottom wall 256, a top wall 258 spaced vertically from the bottom wall 256, and a generally vertical tubular side wall 260. The sidewall 260 extends between the bottom and top walls 256, 258, and preferably has a lower end 260a connected with the bottom wall 256 and a free upper end 260b. The top wall 258 preferably includes a cover or plate 264 removably connectable with the side wall upper end 260a so as to provide entrance into the interior chamber 60. Further, each of the body walls 256, 258 and 260 has an inner surface 256a, 258a, and 260a, respectively, which define the interior chamber 60. Furthermore, the side wall 224 preferably has a lower opening 266 and an upper opening 268 each formed therewithin (e.g., cut, punched, drilled), the lower opening 266 providing the inlet port 62 and the upper opening 268 providing the outlet port 64. Most preferably, the housing 250 is provided by a

commercially available, generally cylindrical drum, but may be specially manufactured and/or formed in any other appropriate structure.

Further, the housing 250 also includes a support member 270 disposed within the housing chamber 60, so as to divide the chamber 60 into a lower chamber section 60a and an upper chamber section 60b. More specifically, the support member 270 is spaced vertically above, and extends generally parallel with, the housing bottom wall 256. Preferably, the inlet port 62 is directly fluidly connected with the lower chamber section 60a and the outlet port 64 is directly fluidly connected with the upper chamber section 60b. Furthermore, the support member 270 has an upper surface 270a for supporting the first reactive material 52, an opposing lower surface 270b, and at least one and preferably a plurality of flow passages 272 each extending between the upper and lower surfaces 270a, 270b to fluidly connect the upper and lower chamber sections 60a, 60b. Preferably, the support member 270 includes or is provided by a generally circular, perforated plate or screen 274 having a plurality of through-holes each providing a separate flow passage 272. The support member plate 270 is retained spaced above the bottom wall 256 by friction or interference, but may be retained by any other appropriate means (e.g., brackets, fasteners, ledge(s)).

Further, the second removal unit 54 includes a housing 275 constructed generally identically as the housing 40 of the air treatment device first construction 39 as described above. Specifically, the housing 275 has inner wall surfaces 222a, 224a defining the second unit housing chamber 61, an upper open end 224a defining the second unit outlet port 65, and an opening 225 formed in the side wall 224 providing the second unit inlet port 63. Further, a support member 228 is disposed within and dividing the chamber 61 into lower and upper chamber sections 61a, 61b fluidly connected by passages 230, the inlet port 63 being fluidly connected with the lower chamber section 61a. Although the second removal unit 54 is preferably formed generally identically as the first treatment device construction 39, the second removal unit 54 may be formed in any other appropriate construction that enables the second treatment device construction 59 to function generally as described herein.

Still referring to Fig. 27, the second construction treatment device 59 preferably further includes a fluid channeling member 280, preferably provided by flexible tube or hose 281, but may be provided by a rigid pipe or otherwise. The channeling member 280 has a first end 280a connected with the first removal unit outlet 64 and a second end 280b connected with the second removal unit inlet 63. As such, the channeling member 280

fluidly connects the first unit upper chamber section 60b with the second unit lower chamber section 61a.

Further, the fan 58 of the second construction treatment device 59 is preferably disposed within or located adjacent to the upper opening 168 of the first unit housing 250, so as to be supported by the housing 250. However, the fan 58 may alternatively be disposed at any other appropriate location, such as within the channeling member 280, within the inlet opening 225 of the second unit housing 275, within either chamber 60, 61. As with the first construction fan 46, the fan 58 is preferably electrically powered and operated by a controller 48 connected with a sensor 47 of a monitoring device 240. Furthermore, the fan 58 is most preferably either an ETRI Model 595DH fan or a Nidec Model A34148 fan, but may be any other appropriate available fan or even a specially manufactured device.

As discussed above, one of the first and second reactive materials 52, 56 is a desiccant configured to remove water from air and the other material 52, 56 is a carbon-dioxide absorbent. Most preferably, the first reactive material 52 is a desiccant 53 and the second reactive material 56 is the carbon-dioxide absorbent 55, such that the first removal unit 50 functions to remove water and the second removal unit functions to remove carbon dioxide. However, the first material 52 may be the carbon dioxide absorbent and the second material 54 may be the desiccant, such that the functions of the removal units are reversed. The desiccant is preferably calcium chloride, for example PELADOW® calcium chloride pellet or DOWFLAKE®, calcium chloride flake from the Dow Chemical Company of Midland, Michigan. Alternatively, the desiccant may be silica gel, which is a partially dehydrated form of polymeric colloidal silicic acid, or Calcium oxide, which is calcinated or recalcinated lime, or Calcium Sulfate, better known commercially as DRIERITE® from W.A. Hammond DRIERITE Co., Ltd., of Xenia, Ohio. The carbon dioxide absorbent is preferably SodaSorb, as discussed above, may alternatively be a granular mass of calcium hydroxide, sodium hydroxide, or potassium hydroxide, or a combination of these with soda lime, for example, SOFNOLIME from Molecular Products of the United Kingdom.

With the above structure, the second preferred construction 59 of the air treatment device 16 basically functions as follows. When the preferred monitoring device 240 determines that the carbon-dioxide level exceeds the desired limit, the preferred controller 48 activates the fan 58, which causes a portion F_{AC} of the enclosure air A_E to be drawn into the first unit inlet port 62. The air flow portion F_{AC} enters the lower chamber section 60a

and then flows through the passages 272 and into the mass of desiccant material, such that at least a portion of any water in the air flow portion F_{AC} is removed by contact with the desiccant. The air flow portion F_{AC} then flows through the upper chamber section 60a, passes through the fan 58 and throughout the channeling member 280 and enters the second unit inlet port 63. The air flow F_{AC} enters the lower chamber section 61a, passes through the support member passages 230 and flows through the mass of carbon dioxide absorbent material 56 within the upper chamber section 61b, such that at least a portion of the carbon dioxide within the air flow F_{AC} reacts with the granules of reactive material 56. The "treated" air flow portion F_{AC}, having a substantially reduced carbon-dioxide content, flows out of housing outlet port 65 and mixes back with a remainder of the enclosure air A_C. Thereby, the total amount of carbon dioxide and water within the enclosure air A_C is reduced. Such air flow through the treatment device 16 occurs generally continuously until the overall carbon dioxide level in the enclosure air A_E is reduced below a certain level. At that point, the preferred controller 48 deactivates or "turns off" the fan 58 or a person within the enclosure 12 may manually turn off the fan 58.

Although the above structure is presently preferred, the second construction air treatment device 59 may be formed in any other appropriate manner. For example, the second construction 59 may include a single housing 290 for both removal units 50, 52, as shown in Fig. 28. Specifically, the housing 290 has an outer surface 290a, a first interior cavity 292 providing the first unit interior chamber 60 and a second interior cavity 294 spaced from the first interior cavity 290 and providing the second unit chamber 61. An interior passage 296 has a first end 296a providing the first unit outlet port 64 and a second end 296a providing the second unit inlet port 63, the first unit inlet port 62 extending between the outer surface 290a and the first cavity 292 and the second unit outlet 65 extending between the outer surface 290a and the cavity 294. The housing 290 may either be a single, integral structure or may include a lower housing portion 290a providing the first unit chamber 60 and a separate, second housing portion 290b removably disposed upon the lower housing portion 290a and providing the second unit chamber 61.

Referring to Fig. 29, another alternative air treatment device 16, or "third construction" device 300, preferably includes a housing 302 having an interior chamber 304, the reactive material 18 being disposeable within at least a portion of the chamber 304. A fluid channeling device 306 has an inlet 308 fluidly connected with the enclosure chamber C_E, an outlet 310 disposed within the housing chamber 304 and a passage 312 extending between the inlet 308 and the outlet 310. A fan 314 is fluidly coupled with the

channeling device 306 so as to be configured to initiate air flow F_{AC} from the enclosure atmosphere A_B into the inlet 308 and from the outlet 310 into the housing chamber 304, such that when the reactive material 18 is disposed within the chamber 304, the air flow F_A passes through the material 18 and the reactive material 18 removes carbon dioxide from the air flow F_A, as depicted in Fig. 29.

Preferably, the housing 302 is formed as a generally hollow, cylindrical body 316 having an open upper end 316a and a closed lower end 316b. More specifically, the cylindrical body 316 includes a circular base wall 318 and a generally tubular sidewall 320 having a lower end 320a attached to the base wall 318 and an upper end 320b forming an opening 322. Preferably, the side wall 320 has a tapering diameter that increases from the lower end 320a to the upper end 320b, such that the diameter (not indicated) of the opening 322 is larger than the diameter (not indicated) of the base wall 318, for reasons discussed below. Further, the sidewall upper end 320b preferably includes a pair of generally aligned notches 324 used to support the preferred fluid channeling device 306, as described below.

Furthermore, the air treatment device third construction 300 preferably further comprises a screen 326 disposed within the housing 302 and configured to generally divide the housing interior chamber 304 into a first, material retainer subchamber 328 and a second, flow or plenum subchamber 330. The screen 326 is further configured to fluidly connect the two chambers 328, 330. More specifically, the screen 326 has a plurality of flow ports or openings 327 each extending between and fluidly connecting the material subchamber 328 and the plenum subchamber 330. Further, the screen 326 also preferably includes a central opening 329 sized to receive a portion of the preferred fluid channeling device 306 such that the fluid channeling device 306 extends between the two chambers 328 and 330. Preferably, the screen 326 is provided by a circular metal plate having the openings 327, 329 formed or cut therein, but may alternatively be provided by a mesh or other type of wire screen. With the tapered housing body 316 as described above, the screen 326 fits within the cylindrical body 316 such that the outer perimeter 326a of the screen fits or wedges against the inner surface 321 of the sidewall 320, thereby centering the central opening 329 within the housing 302. Further, the diameter of the screen 326 is preferably sized such that screen 326 becomes located at about a pre-selected height above the housing base wall 318, thereby establishing the plenum subchamber 330 having about a particular predetermined volume.

Still referring to Fig. 29, the fluid channeling device 306 preferably includes a first, inlet pipe 334 providing the inlet 308, a second, outlet pipe 336 providing the outlet 310 and a connector 338 configured to fluidly connect the first and second pipes 334 and 336. Preferably, the channeling device 306 also includes a diverter 340 configured to divide the air flow into at least two streams within the plenum subchamber 330 and to divert the air flow from a generally vertical direction to a generally horizontal direction, as described below. Further, the channeling device 306 preferably also includes a third, inlet pipe 342 fluidly connected with the connector 338 and providing another or second inlet 346. As such, the fluid channeling passage 312 extends from each inlet 308, 346 and into the connector 338, through the second pipe 336 and out of the outlet 310 and into the diverter 340. With the preferred structure described above, when the channeling device 306 is installed within the air treatment device 16, the first and third pipes 334, 342 extend across the top end 320b of the body sidewall 320, such that a portion of each pipe 334 and 336 is disposed within a separate one of the notches 324 and thereby support or suspend the channeling device upon the housing. Further, the second, vertical pipe 336 extends generally through the center of the housing body 316 and through both chambers 328, 330, a portion of the pipe 336 being disposed within the screen central opening 329 and the diverter 340 is disposed within the plenum chamber 330.

Preferably, each of the two inlet pipes 334 and 342 includes a bended, generally L-shaped tubular body 344 with a first open end 344a providing the two inlets 308 and 346 and a second open end 344b attached to the connector 338. When the channeling device 306 is installed into the housing 302 as described above, each inlet pipe body 344 has a first portion 345 extending generally horizontally from the connector 338 and outwardly across the sidewall top end 320b, and a second, generally vertical portion 347 extending downwardly along the sidewall 320 such that the inlets 308 and 346 are disposed generally about the same height as the housing base wall 318. As such, the air flow initiated by the fan 314 draws air located at a lower height within the disclosure atmosphere A_E, which contains a greater percentage of carbon dioxide as carbon dioxide has a substantially greater mass than oxygen. Further, the second, outlet pipe 336 has a generally straight, generally vertical tubular body 350 with a first open end 350a providing the outlet 310 and a second open end 350b attached to the connector 338. Preferably a stepped adapter collar 352 connects the outlet pipe 336 with the connector 338 as the pipe second end 350b has a smaller diameter than the connector opening into which the pipe 336 is fluidly connected, as discussed below.

Furthermore, the connector 338 has an interior chamber 339 fluidly connected with the passage 312 and sized to receive the fan 314, such that the fan 314 is preferably supported by the channeling device 306.

Further, the connector 338 is preferably formed with a T-shaped body 354 having two inlet openings 356, an outlet opening 358 and two passages 359 extending between and fluidly connecting the openings 356 and 358, the chamber 339 being formed at the intersection of the connector passages 359. Most preferably, the connector 338 is provided by a commercially available "Tee" pipe connector, but may be specially manufactured or formed with any other appropriate shape (e.g., an elbow or block), particularly if the channeling device 306 includes only a single inlet pipe 334. Furthermore, the diverter 340 preferably has a T-shaped body 360 having three openings, an inlet opening 362 and two outlet openings 364, and an interior passage 366 extending between and fluidly connecting the inlet opening 362 with the two outlet openings 364. Most preferably, the outlet pipe 336 and the diverter 340 are integrally formed and provided by a commercially available Tee-pipe, but may be formed of separate parts joined together by appropriate means, such as a threaded connection, adhesive material, weldment, etc.

Still referring to Fig. 29, the fan 314 is preferably located within the connector interior chamber 339 so as to be disposed proximal to the outlet opening 358 and orientated such that the axis 315a of the fan blades 315 extend generally parallel with the centerline (not indicated) of the outlet pipe 336. Further, the fan 314 is preferably an electric-powered fan and the removal device further comprises a power supply 370 configured to provide electrical power to the fan 314. The power supply 370 preferably includes an electric cell battery 372 and a plurality of electrical lines 374 operatively connecting the battery 364 with the fan 314. Furthermore, the fan 314 is preferably a commercially available fan and most preferably a Pabst model RFL100-11/12. Although the above electric fan 314 is preferred, the fan 314 may be any other appropriate fan device, such an pneumatic fan driven by a compressor or a manually driven fan.

Furthermore, the reactive material 18 is a preferably in the form of a granular mass and is refillably disposed within the material retainer subchamber 328 by filling or pouring the mass of granules into the housing upper end 320b. The granules of reactive material 18 fall upon the screen 326 and accumulates within the retainer chamber 328 until the material mass reaches a particular height H_M above the screen 326, which is important for reasons discussed above. As with the treatment devices discussed above, the reactive material 18 is preferably a carbon dioxide absorbent containing an alkali hydroxide, and is

most preferably SodaSorb® HP Indicating mixed with an odor absorbent, as discussed above.

With the structure as described above, the air treatment device third construction 300 basically functions as follows. The fan 314 is started, either automatically by a controller or manually by a switch (neither shown), causing an air flow F_{AC} to be drawn from the enclosure air A_E and into the each inlet 308. The air flow F_{AC} passes through the fan blades 314a and into the outlet pipe 336, enters the diverter 340, and is divided into separate two flow portions that spread across the plenum chamber 330. The air becomes pressurized within the plenum chamber 330 and then the pressurized air flow F_{AC} passes vertically upwardly through the screen openings 327 into the retainer subchamber 328. The air reacts with the granules of reactive material 18 within the chamber 328, such that carbon dioxide is removed from the air flow F_{AC} and then the flow F_{AC} passes out of the housing 302 through the housing opening 322.

Referring now to Fig. 30, another alternative construction of the air treatment device 16, or a "fourth construction" device 380, is generally similar to the third construction device 300 as described above, but with the following differences in the structure of the housing 302 and the fluid channeling device 306. Specifically, the housing 302 is constructed without the screen 326, such that the housing interior chamber 304 is undivided and extends from the base wall 318 upwardly through the chamber 304, the reactive material 18 fills the entire lower portion of chamber 304. Further, the channeling device 306 is formed without the diverter 340 so that the air flow F_A discharges directly from the outlet pipe 336 and into the mass of reactive material 18. Otherwise, the fourth construction device 380 functions basically the same as the third construction device 300 discussed above.

Referring to Figs. 31 and 32, yet another alternative construction of the air treatment device 16, or "fifth construction" device 382, does not include a fan or other means of forced-air convection and relies solely on the natural convection or air currents within the enclosure atmosphere A_E. The air treatment device 382 basically comprises a frame 384 and at least one screen 386 disposed within the frame 384 and having a plurality of apertures 387. A quantity of a reactive material 18 is disposed upon the screen 386 so as to be exposed to the enclosure air A_E and is configured to remove carbon dioxide from air. As such, when the air treatment device 382 is disposed within the enclosure chamber C_E, portions of the enclosure air naturally convect through the apertures 387 to contact the material 18 to substantially remove the carbon dioxide from the air flow portions F_{AC}.

Preferably, the screen 386 is a first screen and the fifth construction treatment device 382 further comprises a second screen 388 having a plurality of apertures 389 and being spaced from the first screen 386 in a generally overlying relationship such that the material 18 is retained in a chamber 390 defined between the two screens 386, 388. Preferably, the frame 384 includes a plurality of legs 385 configured to support the frame 384 and configured to stackably connect with the frame 384 of a second air treatment device 382 (not shown). The reactive material 18 may be any appropriate material for removing carbon dioxide from air, as discussed above with the other constructions of the air treatment device 16.

Referring to Figs. 33-36, the shelter system 10 preferably further comprises a connector unit 400 attached to the enclosure 12 and configured to electrically connect at least one and preferably a plurality of electrical devices 402 located within the enclosure chamber C_E with an electrical power supply 404 located within the environment E. Preferably, the connector unit 400 is also preferably configured to fluidly connect at least one fluid device 405 located within the enclosure chamber C_E with a fluid supply 408 or a fluid device 410 located within the environment E, and also to connect a waste receptacle or "toilet" 412 located within the enclosure chamber C_E with a waste depository 414 located in the environment E. Additionally, the connector unit 400 is further configured to substantially prevent air flow both through the connector unit 400 and between the connector unit 400 and the enclosure 12. As such, the connector unit 400 enables the one or more persons located within the enclosure 12 to use electricity to power electrical devices 402, such as a television set 411, a radio 413, a computer 415, a fan 46/58, an air conditioner, etc., to have access to the internet, to be provided with fluid (e.g., water) from the environment E, and to dispose of bodily waste.

The connector unit 400 includes a base 420 connectable with the enclosure 12 and having at least one and preferably a plurality of line passages 422 each sized to receive a portion of an electrical line 424, a fluid line 426 or a waste line 427, such that the line(s) 424, 426, 427 extend between the environment E and the enclosure chamber C_E through the base 420. The base 420 preferably includes a generally rectangular connector box 428 configured to support the various lines 424, 426 and 427, as described below, and a relatively larger, generally rectangular stand 429 disposed beneath and configured to support the box 428. Preferably, the enclosure 12 has a connector opening 431 extending through one of the side walls 74 and having edges/edge surfaces 431a. The box 428 is disposed within or adjacent to the enclosure opening 431, with the opening edges 431a

being attached to the box 428, most preferably to an interior wall 434 thereof, so as to thereby attach the connector unit 400 to the enclosure 12. The opening 431 is sealed, preferably by means of a flexible sealant material (e.g., tape) overlapping the opening edges 431 and the wall face 434a, to substantially prevent air flow therethrough, and thus preventing environment air E from entering, and enclosure air A_C from exiting, the enclosure chamber C_E. Further, when the connector unit 400 is attached to the enclosure 12, the stand 429 is preferably disposed externally of the enclosure 12.

Preferably, the connector box 428 includes two spaced apart, interior and exterior interface walls 434, 436 and four side walls 437 extending between and connecting the interface walls 434, 436, the six walls 434, 436, 437 defining an interior chamber 430. The interface walls 434, 436 each have at least one and preferably a plurality of interior and exterior openings 435, 437, respectively, each wall opening 435, 437 being aligned with a corresponding opening 437, 435 of the other wall 436, 434, respectively. As such, each pair of aligned openings 435, 437 provides the opposing ends of a separate one of the line passages 422. Further, the base 420 includes a mass of sealant material 438 disposed within the box interior chamber 430 and configured to substantially prevent air flow through the base 420, and particularly to prevent any environment air A_E that may enter the outer openings 437 from flowing to the inner openings 435. Preferably, the sealant material 438 is a filler substance that is pourable into the box chamber 430 in a fluid or semi-fluid state and hardenable into a generally solid mass that substantially occupies the chamber 430 and seals all openings therethrough, such that air flow through the chamber 430 is substantially prevented. Preferably, the sealant material 438 is either polyurethane foam or potting compound, but any other appropriate filler substance may alternatively be used.

Presently, the connector unit 400 preferably includes the following electrical lines 424, fluid lines 426, and waste line 427. At least one and preferably two of the electrical lines 424 are each a power line 442 engageable with at least one electrical device 402 located within the enclosure 12. Specifically, each power line 442 includes an inner socket 444A disposed within one inner wall opening 435, an outer socket 444B disposed within the aligned outer opening 437, and three conductive wires 446 extending between the two sockets 444A, 444B. The inner sockets 444A are each configured to accept a male plug (not shown) from an electric device 402 (as discussed above), such that the inner socket provides a "power outlet". The outer sockets 444B are each configured to either accept a plug from a power cord (not shown) connected to a standard electrical outlet P_E in

the environment E or are alternatively "hard wired" directly into a power line (not shown) located in the environment E. Alternatively, one or more of the power lines 442 may be hard-wired directly to both a power line in the environment E and an electrical device 402 in the enclosure chamber C_E. Further, three other preferred electrical lines 424 are a cable television line 448, an Ethernet line 450, and a phone line 452, each having an inner socket 448a, 450a, 452a, an outer socket 448b, 450b, and 452b, and a conductive wire 448c, 450c, 452c, respectively, extending therebetween, as best shown in Figs. 34 and 35.

Further, at least one and preferably two fluid lines 426 are each a water supply line 458 configured to permit water to flow into the enclosure chamber E_C. Each water supply line 458 preferably includes a fluid channeling member 460, preferably a standard tubular pipe, having a portion 461 disposed within one pair of aligned wall openings 435, 437 so as to extend through a line passage 422 of the box 428. Preferably, one end 460b of the pipe 462 is fluidly connected with a water piping system 408 in the environment E, such as a conventional home or building water system, and the other end 460a is connected with a faucet 464 disposed within the enclosure chamber C_E, as best shown in Fig. 36. As such, a person located within the enclosure 12 is provided with water by operating the faucet 464 so that water flows from the water environment water system, through the pipe 462 and out of the faucet 464. Further, a shower (not shown) and a sink (not shown) may be provided within the enclosure chamber C_E and be fluidly connected with the piping system 408 (or other fluid source) by means of one or more of the water supply lines 458.

As best shown in Fig. 36, two of the fluid lines 424 are a refrigerant "in-line" 466 and a refrigerant "out-line" 468 configured to channel a refrigerant between a first heat exchanger 470 disposed within the enclosure chamber C_E, which is configured to absorb heat from the enclosure air A_C, and a second heat exchanger 472 disposed in the environment E. The refrigerant in-line 466 has a first end 466a fluidly connected with the first, interior heat exchanger 470 and a second end 466b fluidly connected with the second, exterior heat exchanger 472 and is configured to channel compressed or "cooled" refrigerant into the first heat exchanger 470. The out-line 468 has a first end 468a fluidly connected with the interior heat exchanger 470 and a second end 468b fluidly connected with the exterior heat exchanger 472 and is configured to channel expanded or "heated" refrigerant from the first heat exchanger 470 back to the second heat exchanger 472, which preferably includes a compressor.

As depicted in Fig. 36, each refrigerant fluid line 466, 468 includes a flexible pipe or hose section 474 extending from the connector box 428 to the first heat exchanger 470

and a rigid pipe section 476 fluidly connected with the flexible section 474. The rigid pipe section 476 has a first portion 476a disposed within the connector box 428 and a second portion 476b extending from the box 428 to the second heat exchanger 472. By providing the flexible hose section 474, the interior heat exchanger 470 or "air conditioner outlet" can be readily moved between various locations within the enclosure chamber C_E, while maintaining the necessary fluid connection with the exterior heat exchanger 472. Most preferably, the first and second heat exchangers 470, 472 are provided by a FREECOM model RCS-S3000T portable split air conditioner commercially available from Northstar Industries, Inc. of Honolulu, Hawaii.

Still referring to Figs. 33-36, two other fluid lines 424 are preferably each a drain line 478 configured to channel waste fluids (e.g., used shower water or sink water) out of the enclosure chamber C_E and each includes a pipe 479. Each drain pipe 479 has a portion 479a extending through the box 428, an interior end (not shown) disposed within the enclosure 12 and a second, exterior end (not shown) located within the environment E. Further, the waste line 427 includes at least one channeling member or pipe 480 having a portion 480a disposed within the box 428 and extending through one pair of aligned wall opening 435, 437 and the box interior chamber 430. The pipe 480 has an interior end 483 connected with a receptacle 482 located in the enclosure 12 and configured for use as a toilet seat and/or urinal, and an outer end 485 connected with a waste depository 484 located in the environment E, as best shown in Fig. 36. Preferably, the pipe 480 has a bended portion 480b configured to provide a water trap, in other words, the bended portion 480b is fillable with water and functions to prevent air from entering the enclosure chamber C_E through the bore of the pipe 480. Furthermore, the connector unit 400 preferably further includes a manual pressure relief valve 486 and an automatic pressure relief valve 488 each configured to permit a portion of the enclosure air A_C to be discharged to the exterior environment E in the event that the air pressure within the enclosure chamber C_E exceeds a predetermined level, for example 0.2 inches of water.

Further, the shelter system 10 is preferably provided with a sufficient quantity of oxygen generating material 28, reaction initiating material 34 and catalyst 36 (or alternatively oxygen candles 144) for the oxygen generator 14, a sufficient quantity of reactive material 18, preferably the carbon dioxide absorbent 56, and desiccant material 53 for the air treatment device 16, the various materials being disposed within appropriate containers (e.g., buckets, bags, etc.), and a plurality of spare batteries 236 or 372 for the fans 46 or 58, stored within at least one enclosure section 20 so as to be readily available

for use. Further, a sufficient supply of food and drinking water should also be stored within the collapsed enclosure 12 such a desired number of persons are sustainable within the shelter system 10 for a prolonged period (e.g., two or four weeks).

Referring now to Figs. 1-7, the safe room system 10 of the present invention is utilized in a building application generally in the following manner. When an event involving dangerous agents (i.e., chemical, biological or radiological) occurs, at least one person or "user" first deploys the enclosure 12 from one or more storage locations, either from one or more of the rooms R_n to be incorporated into the shelter 10, as depicted in Figs. 4-6, from a separate room(s) R_n or even a location external of the building B. Preferably, each separate enclosure section 21A, 21B, 21C, etc. is first placed within or if already so located, laid out in, the associated room R_1, R_2, R_3, respectively, as shown in Fig. 6. Then, each section 21A, 21B, 21C, etc. is arranged or positioned in the deployed, usage configuration by utilizing the connectors 76 to attach the ceiling wall 72 and side walls 74 to proximal room walls R_C, R_S, respectively, and/or by using one or more supports 78 to maintain the ceiling wall 72 spaced above the base wall 70. Next, each enclosure section 21A, 21B, 21C, etc. is connected with the adjacent enclosure section 21A, 21B, 21C, etc. by one or more connective portions 75, most preferably by removably connecting adjacent passage openings 71 by means of the inserts 122 and then sequentially deploying each connected enclosure section 20. Alternatively, if the enclosure sections 21A, 21B, 21C, etc. are permanently connected, the entire enclosure 12 is laid out throughout the two or more rooms R_n, and then each section 21A, 21B, 21C, etc. is deployed using the connectors 76 and/or support members 78. Further, one or more appliance fixtures F_n may be incorporated into the shelter 10 by disposing each fixture F through an access opening 22 and then sealing the opening 22 with an air-impermeable connector 33. Additionally, the connector unit 400 is preferably utilized to connect various electric devices 402, fluid devices 405, and a toilet 412 each located within the enclosure chamber C_E to corresponding elements within the environment E.

Preferably, the enclosure door opening(s) 86 remain opened for an initial period after the enclosure 12 is deployed, if no dangerous agents are present in the immediate vicinity of the building B, in order to fill the enclosure interior space with an initial atmosphere A_E, and then the door opening(s) 58 are sealed with the cover(s) 60. At some point, either once the enclosure air A_C is isolated or sealed from the environment air A_E, or a period of time thereafter, a person within the enclosure 12 places or pours a quantity of the reaction initiating material 34, catalyst material 36 and oxygen generating material 28

within the oxygen generator 14 such that oxygen begins to flow into the enclosure air A_C. This oxygen generating process is repeated periodically, preferably about every twelve hours, for the duration of the time the one or more persons spend within the sealed enclosure chamber C_E.

Further, after the enclosure 12 is sealed, a person places reactive material 18 within the air treatment device 16, and preferably both a desiccant 52 and a carbon dioxide absorbent 56 within the chambers 60, 61, respectively, of the preferred device 16. Preferably, the monitoring device 240 controls the fan 58 (or 46) of the treatment device 16 to operate the device 16 to remove carbon dioxide from the enclosure air A_C when the carbon-dioxide level rises above the predetermined limit as discussed above. Alternatively, the fan 58 or 46 may operate continuously, such as when the connector unit 400 provides electricity, or may be manually operated by a person in the enclosure 12 (i.e., by means of a switch). Furthermore, the person(s) will periodically replace the reactive material 18 when exhausted. Additionally, depending on the size of the total enclosure chamber C_E and the number of persons isolated or sheltered therein, two or more oxygen generators 14 and/or air treatment devices 16 may be utilized in the shelter system 10.

Similar procedures are used for a vehicle enclosure 12, as described above. With a land-based vehicle application, such as a truck T, the interior enclosure section 21A may be separately deployed using the connectors 76 and/or frames 80, while the one or more exterior sections 21B, etc. and decontamination enclosure 90 remain located within the vehicle compartment 96. As such, one or more persons may be isolated within the enclosure chamber C_E while the truck T travels to a desired location. When such a location is reached, the one or more exterior enclosure sections 20 and the decontamination enclosure 90 are deployed, and preferably maintained in the deployed configuration using one or more frames 80. The oxygen generator 14 and air treatment device 16 are operated as discussed above.

It will be appreciated by those skilled in the art that changes could be made to the embodiments described above without departing from the broad inventive concept thereof. It is understood, therefore, that this invention is not limited to the particular embodiments disclosed, but it is intended to cover modifications within the spirit and scope of the present invention as described in the appended claims.